The Green Thumb

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The Cover

Sedum and Blue Grama
Frances Frakes Hansen

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The Xeriscape Demonstration Garden at Denver Botanic Gardens

by Gayle Weinstein

The American public has a steadfast image of what the All-American landscape is: foundation plantings of shrubs; trees located randomly in the lawn; expanses of green turf. Within a few years the shrubs outgrow their location concealing windows or paths. The trees begin to block views and the lawn has a manicured, rich green appearance indicative of weekly chores necessary to maintain this effect.

These landscapes originated in humid areas where annual rainfall exceeds 30 inches per year and where these commonly used plants naturally grow. In our semi-arid environment, we receive 12-14 inches annual precipitation. Water needed to keep this landscape green is at least double the natural moisture. Yet we still use this style and its associated plants in Colorado, New Mexico, Wyoming or everywhere USA. We neglect the regional environments and ignore their differences.

In some arid areas there have been attempts to design more suitable landscapes, but they often lack imagination. Frequently they consist of rocks and intermittent shrubs bordering a large area of lush green lawn.

Gayle Weinstein, manager of plant collections at Denver Botanic Gardens, designed the Xeriscape Demonstration Garden in cooperation with Ken Ball, acting consultant and conservation officer with the Denver Water Board.

Creative Landscaping Styles

Landscapes in the Rocky Mountain and Plains states require different styles and vegetation. Responding to a need for change, the Denver Water Department initiated the Xeriscape concept, "creative landscapes through water conservation." The goal of the Denver Water Department and Denver Botanic Gardens is to heighten our awareness of regional climates and resources: to understand and accept the low precipitation, bright sunshine, drying winds and temperature fluctuations. Xeric landscapes are conscious attempts to recognize the environment.

When attempting to change styles, ideas become panaceas and terms become misconstrued. Plastic covered with gravel or rocks was stylish. Recently, "native" has become synonymous with "drought resistant" or "no maintainance." Clearly, native does not necessarily equal the above. Plants adapted to various habitats transcend political boundaries. High mountain plants in Colorado may be as unaccommodating in the Plains as those from other countries.

Plants growing in their natural habitat settle in a niche. From possibly hundreds of seeds, few survive, and survival is often a matter of timing: when the seeds make contact with the soil, how much moisture is available, what is the competition, where are the herbivores. With the foregoing in mind, designing for a region is not that different. Good design still re-

quires planning, proper plant selection and placement.

To maintain a traditional style of design with water conservation, plants more adaptable to the area may be substituted. Early-flowering shrubs such as forsythia might be replaced with a male selection of New Mexican privet (*Forestiera neomexicana*). A large turfgrass cover might be reduced and some replaced with other groundcovers that require less water. Traditional styles can merge with natural designs. Groupings of plants can be extended, defined edges can become less distinct and areas can be unified with common groundcovers. Or the traditional style can be completely eliminated with a complete break into the natural. The recurring theme is flowing space, undefined borders, drifts of plants, subtle and diverse colors and textures, and dynamic changes throughout the year.

DBG's Xeriscape Garden

At Denver Botanic Gardens the Xeriscape Demonstration Garden has been established in cooperation with the Denver Water Board to display naturalistic settings, illustrating areas from which many dryland plants come. This garden is divided into sections depicting arid areas throughout the western half of North America including plains, chaparral, open woodlands, deserts, and parklands.

The plains, an area of low grasses and forbs, are found where the prairies extend into regions of greater aridity as in New Mexico, southeastern Colorado and Arizona. There is a feeling of open, uninterrupted space. Some of the represented vegetation is three-awn grass (*Aristida purpurea*), blue grama (*Bouteloua gracilis*), galetta grass (*Hilaria jamesii*), evening star (*Mentzelia nuda*), and frankenia (*Frankenia jamesii*) a low, attractive, flowering shrub.

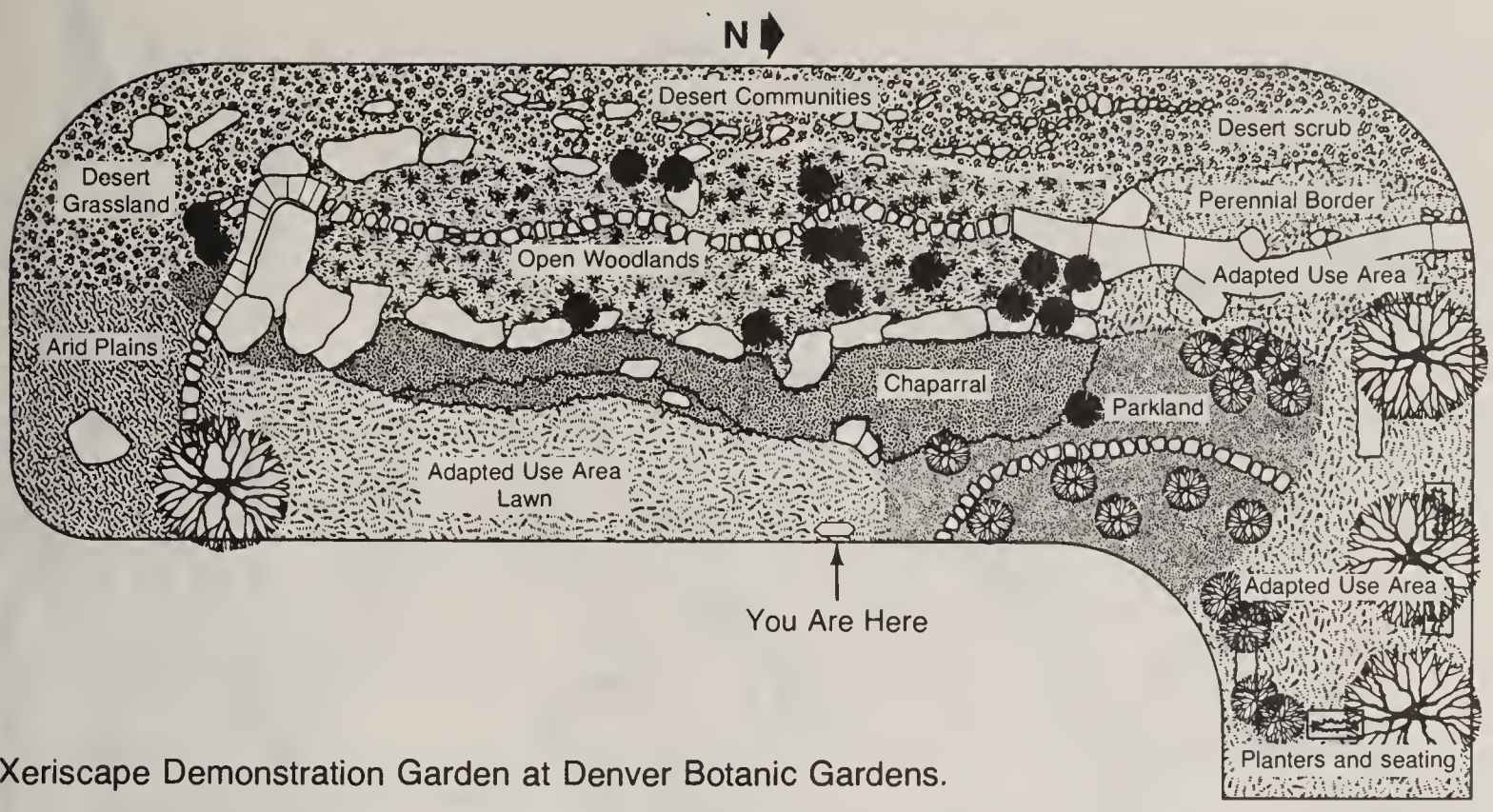
The chaparral, a community of evergreen shrubs with hard, leathery leaves and a unified, dense canopy, is often found growing on hillsides. Plants selected for this area of the garden are manzanitas (*Arctostaphylos*), ceanothus (*Ceanothus*), and sage (*Artemisia*). Chaparral is found in the Mediterranean climates of coastal California and the interior of Arizona; a similar community exists in western Colorado on the Uncompahgre Plateau.

Open woodlands, often referred to as pygmy forest, are primarily dominated by pinyon pines (*Pinus edulis*), and singleseed (*Juniperus monosperma*) or Utah junipers (*J. osteosperma*). The openly spaced trees are interspersed with Mormon tea (*Ephedra*), juneberries (*Amelanchier*) and many herbaceous perennials. This community is found extensively on Colorado's West Slope, where foothills and mesas are dry but still have enough moisture to support trees.

The desert areas of the Xeriscape Garden have several communities represented by leafy or stem succulents, shrubs, grasses and other herbaceous plantings. The desert grassland is a perennial grass-shrub dominated landscape, differing from prairie grassland in that the groundcover is uneven, interrupted by shrubs.

The parkland community in the Xeriscape Demonstration Garden consists of oaks, grasses and intermittent forbs. In Colorado, the dominant tree of a parkland is ponderosa pine (*Pinus ponderosa*). In the central valley of California the dominant canopy would be live oak, which, in late summer and fall, colors the landscape with sweeps of gold, dotted green.

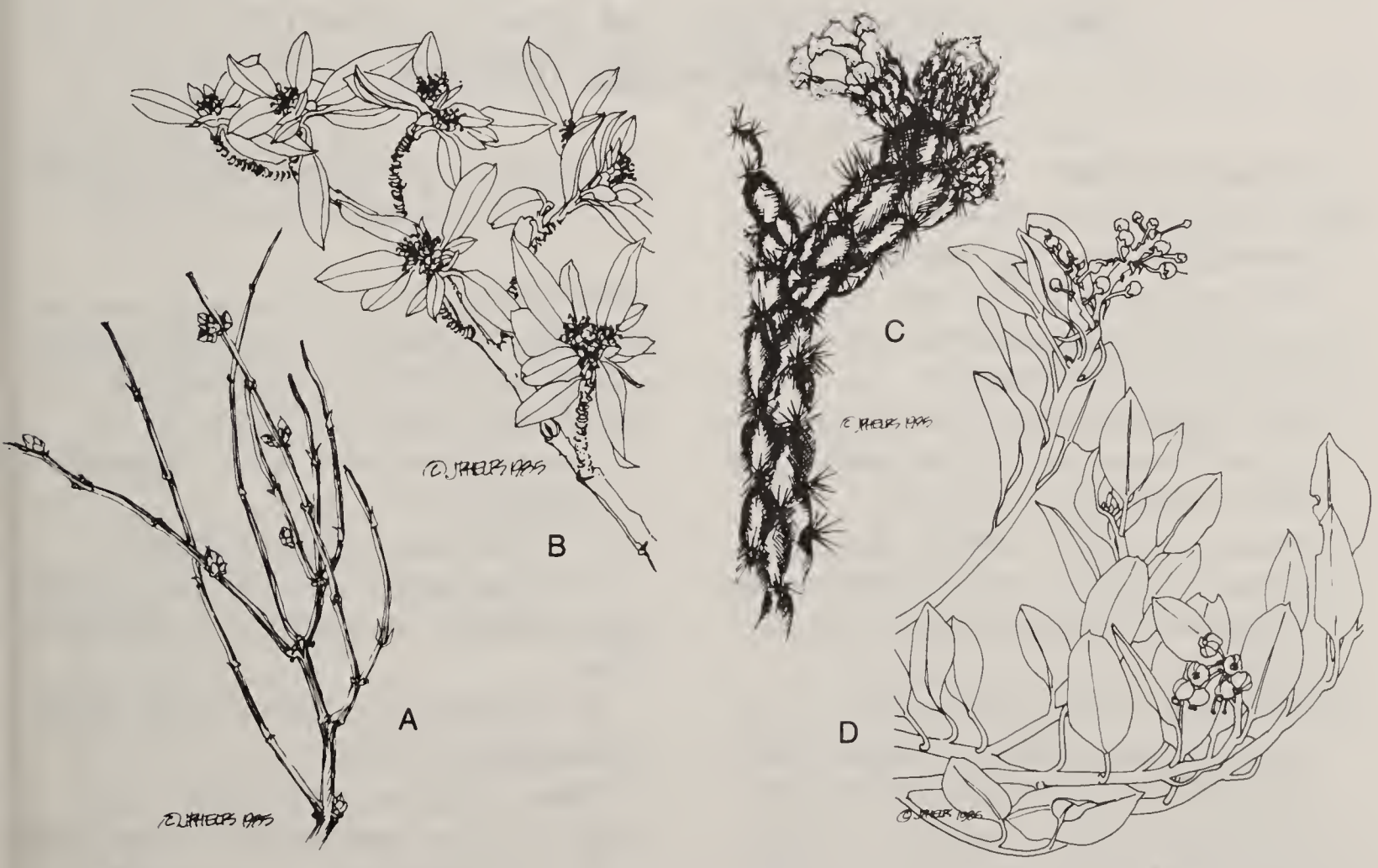
Adapted use areas in the Xeriscape Garden serve to illustrate use of some of the dryland plant materials in a more conventional fashion though still integrated with the environment and still employing xeric concepts. Dryland wildflowers, set in a traditional perennial border, include penstemons (*Penstemon*), zinnias (*Zinnia grandiflora*) and paper flowers (*Psilostrophe bakeri*). The traditional expanse of lawn is planted with native blue grama (*Bouteloua gracilis*).



Xeriscape Demonstration Garden at Denver Botanic Gardens.

Changing a landscape involves an honest and economical response to the conditions of the site. Gardens that conserve water capitalize on a variety of habitats, orientation, and topography in order to best suit the site. The design objectives of the Xeriscape Garden display plant materials known to have low water requirements. Cultural separations of plant materials and livable space are desirable landscape features. Plants shown in a naturalistic setting instill an appreciation for the more arid parts of the world and create an awareness of the variety and attractiveness of dryland plants.

Although change is slow, our awareness is imperative in order to conserve and protect our natural resources.



A. *Ephedra viridis,* Green Ephedra. B. *Cercocarpus ledifolius,* Curl-leaf Mountain Mahogany. C. *Opuntia imbricata,* Cholla. D. *Arctostaphylos patula,* Greenleaf Manzanita.

Fallugia paradoxa,
Apache Plume.

Bouteloua gracilis,
Blue Grama Grass.

Hilaria jamesii,
Galleta Grass.

Selected examples of plant material in the Xeriscape Garden

Adapted Use Area

Bouteloua gracilis — Blue grama
A bunch grass with flaglike flowers that vary in shades of pink to tan.

Chrysothamnus viscidiflorus ssp. *linifolius* — Rabbitbrush
A shrub, less than 5 ft., with numerous yellow flowers in August; good to use with herbaceous perennials.

Fraxinus anomala — Single-leaf ash
A small tree with single leaves instead of the usual compound leaves of ash trees.

Physaria australis — Twinpod
A low growing herbaceous plant with yellow flowers in spring and attractive dry fruits.

Rhus trilobata var. *simplicifolia* — Three-leaved sumac
A shrub, approximately 5 ft., with edible fruit and red fall color.

Arid Plains

Aristida purpurea — Purple three-awn
A bunch grass with soft purple flowers.

Frankenia jamesii — Frankenia
A small shrub with sprays of small white flowers.

Hilaria jamesii — Galleta grass
A dryland grass with coarse texture.

Melampodium leucanthum — Blackfoot daisy
An herbaceous perennial with white, daisylike flowers.

Verbena wrightii — Verbena
An herbaceous perennial with purplish flowers throughout the summer.

Buchloe dactyloides, Buffalo Grass.

Chaparral

Arctostaphylos x *nevadensis* — Pinemat manzanita
An outstanding broadleaf evergreen shrub, less than 3 ft. tall.

Arctostaphylos patula — Green manzanita
Another outstanding broadleaf evergreen, from 3 to 5 ft. tall.

Cercocarpus intricatus — Littleleaf mountain mahogany
A shrub with small dark evergreen leaves; variable in form.

Cercocarpus ledifolius — Curl-leaf mountain mahogany
A broadleaf evergreen tree; excellent for espalier.

Artemisia cana — Sage
Silver sage with narrow leaves; usually less than 5 ft.

Desert Communities

Chamaebatiaria millefolium — Fernbush
A shrub in the rose family with panicles of white flowers and yarrowlike foliage.

Coleogyne ramosissima — Blackbush
A dwarf rounded shrub.

Cowania mexicana — Cliff rose
A broadleaf evergreen with whitish fragrant flowers.

Fallugia paradoxa — Apache plume
An outstanding shrub with continuous white flowers and feathery seeds.

Juniperus osteosperma — Utah juniper
A small broad tree, less than 20 ft., with outstanding berrylike cones.

Mahonia fremontii — Fremont mahonia
A broadleaf evergreen shrub with hollylike blue foliage.

Opuntia imbricata — Cholla
A tall cactus with magenta flowers.

Pediocactus simpsonii — Mountain ball cactus
A small cactus with delicate pink flowers.

Penstemon palmeri — Palmer penstemon
An herbaceous perennial with blue foliage and pink flowers.

Peraphyllum ramosissimum — Squawbush
A large shrub with applelike fruit.

Open Woodlands

Amelanchier utahensis — Serviceberry
A small shrub of variable size with white flowers and edible fruit.

Antennaria rosea — Pussytoes
A tight, matlike groundcover with silvery foliage.

Cupressus arizonica — Arizona cypress
A needle-leaved evergreen, variable in height.

Ephedra torreyana — Mormon tea
A small shrub with blue stems; good for winter effect.

Ephedra viridis — Mormon tea
A small shrub with green stems; also good for winter effect.

Fendlera rupicola — Fendlerbush
A large shrub similar to mock orange.

Juniperus monosperma — Single-seed juniper
Similar to *J. osteosperma.*

Pinus monophylla — Single-leaf pine
A single needle pine similar to pinyon pine.

Parkland

Bouteloua gracilis — Blue grama grass
A bunch grass with flaglike flowers in various shades of tan to pink.

Eriogonum umbellatum — Sulfur flower
An herbaceous perennial with outstanding yellow flowers.

Quercus gambelii — Gambel Oak
A large shrub or small tree, may be grown singly or in groves.

Lawns *and* Water Conservation

by Dorothy Borland

One of the most controversial elements of Xeriscape is the recommendation to reduce the lawn area. At first thought, this seems to mean that the yard must be in rocks to save water. With some thought one realizes that heavy water-consuming lawn areas can be reduced by adding vegetable gardens, flower gardens, herb gardens or tree and shrub beds. Or, if play areas for children, dog runs or patios and decks better fit one's lifestyle, the lawn will be reduced to accommodate these features.

The goal of the Xeriscape is to promote better awareness of water use in the landscape. Lawns are generally overwatered and closer attention to water schedules will save water immediately. The yard can be redesigned as lifestyles change, generally reducing the amount of lawn. A side benefit often overlooked is the reduction in lawn maintenance required when the lawn is smaller — less time spent mowing and fertilizing.

Another option is to reduce the watering on less visible sections of the lawn, keeping the high maintenance, highly attractive lawn close to the house and in the areas of use. Odd sections of the yard can be treated differently, while still preserving a grass cover.

For those who wish to save greater quantities of water the bluegrass lawn (about 90% of all lawns in the Metro area are bluegrass) can be removed and other more drought tolerant but attractive grasses can be planted. Grasses that have performed well in the Metro area with less water, mowing and fertilization include the turf-type tall fescues, Fairway wheatgrass, smooth brome and buffalograss. The improved turf-type tall fescues will produce a lawn very similar to bluegrass, while the other grasses will produce a coarser textured lawn due to a wider leaf blade. Buffalograss is a warm season grass and will be dormant and tan-colored from mid-September until mid-May.

Traditional lawns often contain perennial ryegrass and fine fescues to provide higher levels of shade tolerance as well as tolerances to certain diseases. However, these grasses should not be considered drought tolerant.

The availability of sod has made us expect an instant lawn. There are only two sod farms currently in the area that carry tall fescue or smooth brome as a sod and only one that offers a warm season buffalograss or native sod. When calling the sod farms, be sure to ask what grasses are in the sod.

Seeding lawns has always been recommended over sodding because of the

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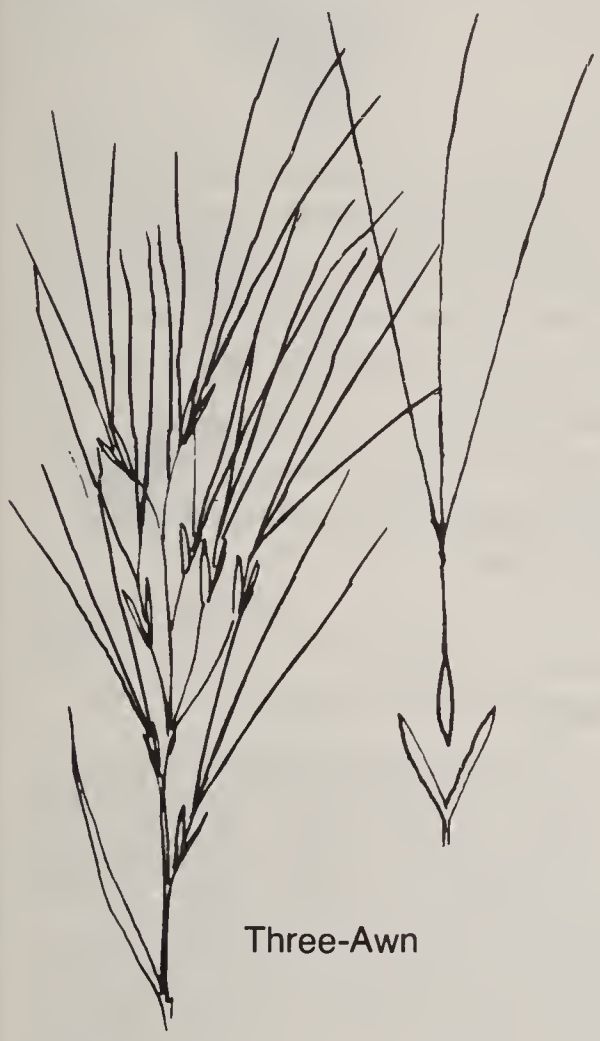
Dorothy Borland was graduated from Colorado State University with a Master of Science in Horticulture (turfgrass emphasis). Through her consulting business, "The Turf Expert," she has been offering evaluations and maintenance recommendations for both alternative and conventional grasses for the past five years.

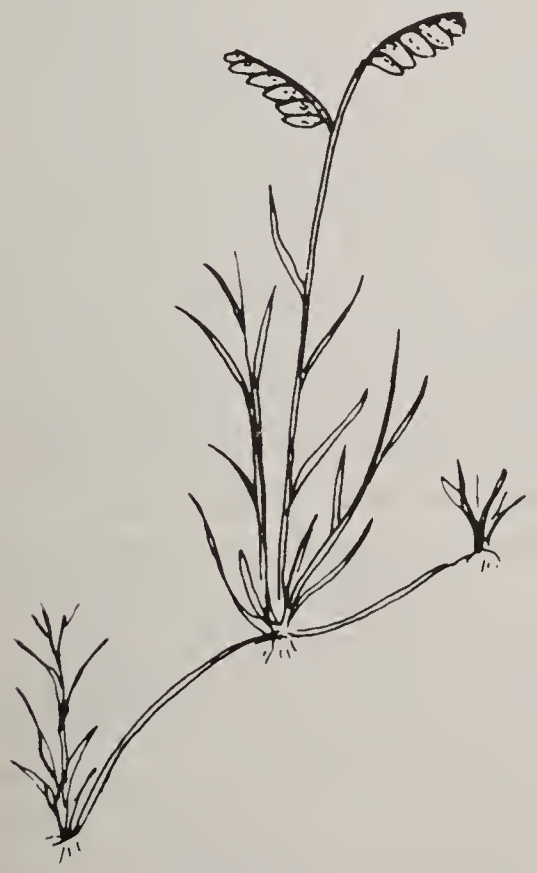
ability to control the grasses and varieties used. However, seeding requires more time and effort for establishing complete cover of grass. Seeding rates for the non-bluegrass species mentioned previously will be higher than with bluegrass due to the larger seed and therefore, fewer seeds per pound. Seed of some of these grasses is more expensive than bluegrass, but the potential long term water and maintenance savings should be considered as well as installation costs.

An interest in water conservation in the landscape does not mean there can be no lawn. With careful attention to watering practices, perhaps modifying the landscape by adding decks or gardens, or by changing the variety of grass in the lawn, your landscape will change in appearance only as much as you wish while still conserving water.

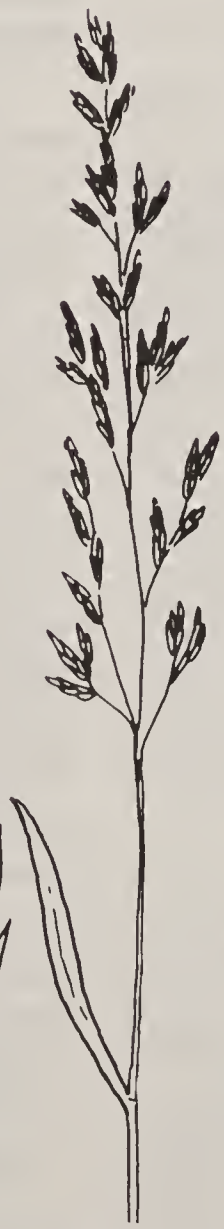


Three-Awn

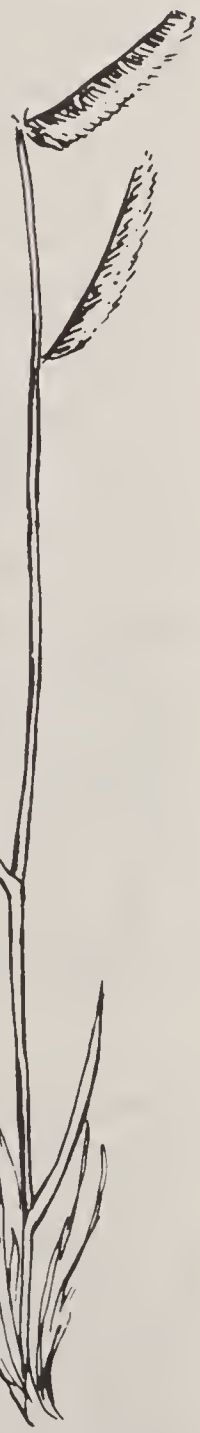
Bromegrass



Buffalograss



Fescue



Grama Grass

Jewels of the Desert — Colorado's Barren Land Plants

by Tamara Naumann

Colorado's least hospitable habitats are the barrens. The Badlands. Barren and lifeless they appear to you and me, yet they provide habitat for many of our most interesting native plants. A surprising number of plant species have adapted to life in the harsh barren land environments of Colorado. Many, in fact, are found nowhere else in the world. Who are these tenacious and little known inhabitants of Colorado's desert country? In these few pages we will tour some of Colorado's notable barren lands where we will meet just a few of the natives.

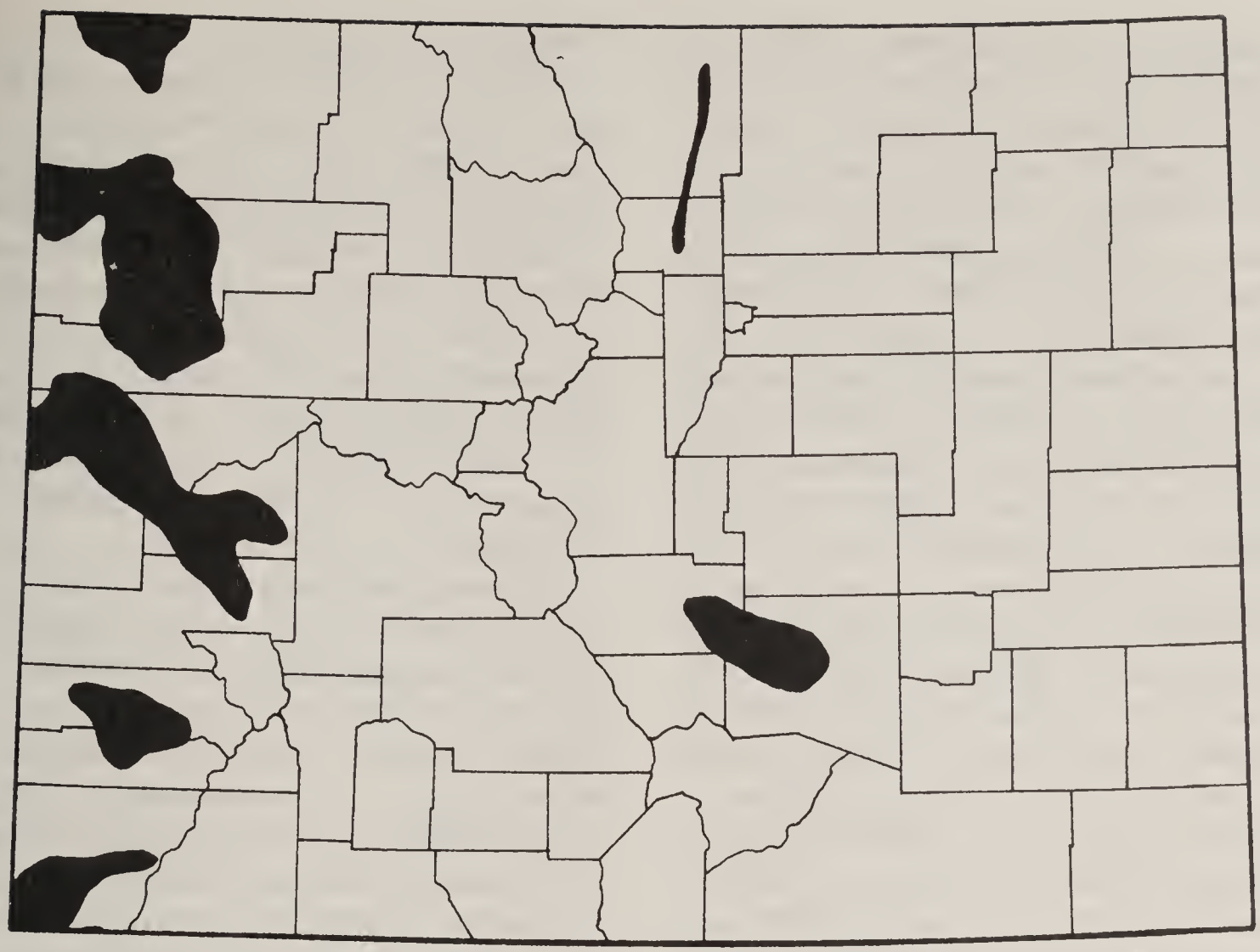
The word 'barrens' is a loosely defined term. In a broad sense it is used to refer to any tract of agriculturally unproductive land, such as the Pine Barrens of New Jersey or the shale barrens of the Uinta Basin. The term is used here to describe sparsely vegetated shale outcrops or shale-derived soils (specifically those of the Mancos, Niobrara, and Green River formations) which are prominent features of the plateau and basin country of western Colorado. Barrens occur sporadically throughout the state, anywhere physical and chemical characteristics of the soil or geologic substrate combine with arid climate to restrict plant growth. Such areas are more extensively developed in western Colorado, but conspicuous examples occur in several localities on the eastern slope, especially along the hogbacks at the base of the Rocky Mountains.

Tamara Naumann is the botanist with the Colorado Natural Areas Program, Department of Natural Resources. In 1982 she served as botanist for the Colorado Natural Heritage Inventory of the Piceance Basin of western Colorado where many of the state's rare and endangered plants occur. In 1984 she did an inventory of the endemic *Physaria bellii* on clay barrens in Boulder and Larimer counties.

Climate and soil — water and salt stress common

Climate and soil chemistry play important roles in the development of barren land plant communities. Water and salt stress are common problems faced by plants inhabiting barren land habitats. In Colorado, barrens are best developed in areas receiving fewer than 12 inches of rain per year. More abundant precipitation can ameliorate soil conditions that would otherwise inhibit plant growth. This relationship contributes to the irregular occurrence of barrens habitats throughout the state. For example, a given substrate may support relatively lush and diverse plant communities on cool, moist north-facing slopes while barrens plant communities occupy warmer and drier southerly exposures. Eastern slope barrens communities tend to be limited in size and extent due to the mitigating effects of increased precipitation during the growing season.

Many of the shale formations in Colorado contain high salt concentrations. Excessive concentrations of salt can be



Areas in Colorado where outcrops of Niobrara, Mancos, and Green River formations support barrens plant communities.

toxic to plants. In addition to toxicity problems, however, high levels of salt in the soil will cause drought stress. The strong affinity of water for salt can prevent water from entering the relatively unsalty roots of plants in an otherwise salty soil environment. Some plants are able to overcome this problem by absorbing salt at the roots. Several species of saltbush (*Atriplex*), for example, absorb salt and transport it to special organs or hairs on the leaf surface where it can be safely stored or shed. Occasionally, other toxic materials such as selenium or boron present additional stresses with which plants must contend.

Plants need oxygen too

Oxygen stress is another potential problem for barren land plants. Shales and shale-derived clay soils are composed of very small mineral particles that are easily compacted. Consequently, gas (oxygen) exchange and water movement can be quite restricted, in part because the space between soil particles is extremely limited. Plant roots require ample oxygen for the hard work of cell division and growth in much the same way that an athlete needs plenty of oxygen to run a race. Oxygen stress will curtail or limit plant growth by inhibiting root growth. While tight soils slow the infiltration of water from the soil surface, water that does enter the soil is also held more tightly by clay soils compared with coarser soils. Small (clay) soil particles have a relatively greater surface area than coarser (e.g., sand) particles. The relative difference in surface area enables clay particles to bind with a greater number of water molecules, rendering them unavailable to plants.

Natural disturbance is often an important element structuring barrens communities on easily eroded, sparsely vegetated substrates. Special structural adaptations such as elastic root systems and

low stature can enhance survival in an inherently unstable environment.

The most conspicuous and extensive shale substrates supporting barrens plant communities in Colorado are the Mancos and Niobrara formations of Cretaceous age and the Green River formation of Tertiary/Eocene age. Extensive inland seas covered much of the American West during the Cretaceous Period (65 to 150 million years ago). The Mancos and Niobrara shales were deposited as mud in these seas. Calcium-rich shells and skeletons of countless marine organisms were deposited with the mud, as were sulfates and other salts. After the present-day Rockies were uplifted and the Cretaceous seas retreated, an immense lake occupied northwestern Colorado for roughly six and a half million years (40 to 50 million years ago). This lake, known as Lake Uinta, advanced and retreated with changes in climate, leaving enormous quantities of salt behind as the water evaporated. Great Salt Lake is a modern, though much smaller, analog of ancient Lake Uinta. Fine sediments deposited in quiet waters of Lake Uinta became the Green River formation, unique for the algae and other microorganisms deposited with the mud which have been transformed into a type of fossil fuel called 'oil shale'.

These three geologic formations account for an astounding number of rare plants, rare in the sense that they occur nowhere else on earth. Many of these 'rare' plants are actually abundant in the habitats where they occur. To better describe plants that are restricted to a particular place or narrowly distributed habitat, botanists use the term 'endemic'. An endemic plant or animal is "prevalent in or peculiar to a particular locality . . . [or] Native or confined to a certain region; having a comparatively restricted distribution" (*American Heritage Dictionary of the English Language,* 1969). Some of our endemic plant species are confined to Colorado. Others creep across the borders into New Mexico, Arizona, Utah, or Wyoming.

Scientists do not fully understand the causes of endemism in plants. Other types of plant rarity have been recognized, but the type frequently exhibited among barren land plants is characterized by extremely narrow geographic distribution, very specific habitat requirements (often restricted to a single geologic formation), and large local population size. A number of ideas have been proposed to explain this interesting phenomenon.

Regional uplift occurring in Miocene and Pliocene times (between 2 and 20 million years ago) initiated a period of extensive erosion which exposed the Mancos, Niobrara, and Green River shale formations. In an evolutionary context these geologic substrates have been exposed and available as habitats for a relatively short time. Our barren land endemics may be narrowly distributed because they evolved recently and have not had time to spread. Scientists use the term 'neo-endemic' to describe such species. A contrasting scenario is exemplified by what are called 'paleo-endemics' — plants which were formerly widespread but are now rare due to climatic or other environmental changes to which they have been unable to adapt. Several of our alpine endemics presumably fall into this category (subject of another article in this series).

If our barren land endemics are in fact 'neo-endemics', what caused their evolution? How did they adapt to harsh badlands environments where few plants venture to make a living? Adaptation to severe habitats may have been a clever trick enabling the ancestors of present-day barren land plants to escape competition from other plant species occupying more 'comfortable' habitats. Acquisition of traits such as salt- or drought-tolerance could enable plants to thrive in sparsely inhabited areas where competition for available resources is low. Studies have shown that many barren land plants fail to thrive when placed in

more hospitable environments if other species are present.

Not all barren land plants have narrow geographic ranges. Low and dusty-looking mat saltbush (*Atriplex corrugata*) occupies saline badlands throughout large areas in Colorado, Utah, New Mexico, and Arizona. Blackbrush (*Coleogyne ramosissima*), galleta grass (*Hilaria jamesii*), and shadscale (*Atriplex confertifolia*) occur throughout the Southwest on a variety of geologic substrates. Gardner saltbush (*Atriplex gardneri*) occurs on saline shales throughout the Great Basin and western Great Plains. Thorny horsebrush (*Tetradymia spinosa*) occurs on badlands as well as in shrub-grassland and pinyon-juniper communities. The adaptations of barren land plants to arid and oftentimes toxic environmental conditions take many and interesting forms. Low stature, diverse surface coverings (e.g. minute hairs) reflective coloration, and succulent leaves are but a few examples of adaptations to drought. Long and often elastic root systems enhance survivorship on inherently unstable substrates. Efficient use and conservation of available resources along with a measure of tolerance of stressful conditions are the keys to survival.

But who — and where — are the rare ones? The narrow endemics of barren land habitats.

Mancos Shale Endemics

The Mesa Verde cactus (*Sclerocactus mesae-verdae*) is found on Ute Mountain Ute tribal lands in Montezuma County and on Navajo tribal lands in San Juan County, New Mexico. Yellow or cream-colored flowers are normally produced in late April or early May, but the entire plant may shrink and disappear below the soil surface during periods of drought. The Mesa Verde cactus is especially threatened by private and commercial cactus collectors and by land use conflicts, including oil and gas exploration, impacts from off-road-vehicle (ORV) use, livestock trampling, and transportation and utility corridors. It was listed as a threatened species under the federal Endangered Species Act in 1979 and is currently the subject of a biological and population monitoring study.

Mancos saltbush (*Atriplex pleiantha*) is known only from the Four Corners area, primarily on Ute Mountain Ute and Navajo tribal lands. This succulent little annual was collected for the first time in 1949 near the Mancos trading post in southwestern Colorado by Dr. William A. Weber of the University of Colorado Herbarium. The species has been nominated for listing as a federally endangered species because of threats to the New Mexico population by mining activities.

The distinction between barrens and desert shrublands can become quite blurred in some instances. Well-developed desert shrublands cover extensive areas of 'adobe' soils derived from Mancos shale in Delta and Montrose counties. It's a matter of degree, as is so often the case in nature, and it may not be important to draw a clear line. The same processes that operate to produce extensive barrens or badlands in southwestern Colorado can operate on a much smaller scale to produce a mosaic of barren microhabitats within a larger landscape unit (e.g., a desert shrubland). One of our federally listed endangered species is found in just such a habitat. Clay-loving wild buckwheat (*Eriogonum pelinophilum*) occurs along a 30-mile stretch of Mancos adobes between the Colorado towns of Delta and Montrose. The habitat of this low, shrub-like plant is threatened by ORV use. Two federal listing candidates, Colorado desert parsley (*Lomatium concinnum*) and adobe beardtongue (*Penstemon retrorsus*), are also endemic to the Mancos adobes in this area.

Niobrara Shale Endemics

Bell's twinpod (*Physaria bellii*) is endemic to Niobrara limestone/shale outcrops in Boulder and Larimer counties. The blue-gray rosettes surrounded by

abundant and conspicuously inflated fruits are visible in late summer on highway roadcuts between Boulder and Lyons and on the hogbacks below Dixon Dam at Horsetooth Reservoir near Fort Collins. *Physaria bellii* appears to thrive in areas where disturbance (nature *or* man-made) has eliminated or reduced the number of potential competitors. Mining of limestone for cement had undoubtedly eliminated signifcant portions of the habitat formerly occupied by this species; it has been nominated for federal listing.

Another Front Range plant, Arkansas River feverfew (*Parthenium tetraneuris* or *Bolophyta tetraneuris*), is found between Pueblo and Canon City on outcrops of the Niobrara and related formations. The known range of this mat-forming member of the sunflower family is contained within Fremont and Pueblo counties. Threats to the Arkansas River feverfew include habitat loss attributed to limestone mining and housing developments, and uncontrolled recreational use. These pressures are expected to increase over the next 50 years, and may seriously threaten the species. *Parthenium tetraneuris* is another federal listing candidate.

Green River Shale Endemics

Moving back to western Colorado we encounter a startling number of oddities endemic to oil shale outcrops of the Green River formation. The sun-loving rue (*Thalictrum heliophilum*) makes its Colorado home in Garfield and Rio Blanco counties. A portion of its range extends into Utah in Grand and Uintah counties. The bluish leaves are reminiscent of a columbine, but the flowers are not at all showy. This unusual meadow rue was not discovered until 1980! It grows abundantly on precipitous outcrops of the Parachute Creek member of the Green River formation, notably along the southern (Roan Cliffs) and western (Cathedral Bluffs) rims of the Piceance Basin. Another candidate for federal listing, *Thalictrum heliophilum* is potentially threatened by oil shale development.

The Piceance (pee-onts) Basin in Garfield and Rio Blanco counties is an especially rich center of plant endemism. In 1982, botanists working in the Piceance Basin discovered three previously unknown species, all in the mustard family! The Dudley Bluffs bladderpod (*Lesquerella congesta*), Piceance bladderpod

Bolophyta tetraneuris, Arkansas River Feverfew.

Lesquerella congesta, Dudley Bluffs Bladderpod.

(*Lesquerella parviflora*), and Piceance twinpod (*Physaria obcordata*) are confined in the Piceance Basin to outcrops of Green River shale or similar shaley portions of the overlying Uinta formation. *Physaria obcordata* is named for its distinctive heart-shaped (cordate) fruits which are attached by the pointed end (whence the prefix ob-). *Lesquerella congesta* is so-named because its leaves and flowering stems are very densely packed together. The plant itself is only an inch or two high, a round ball of tiny grayish leaves and yellow flowers. *Lesquerella parviflora* is named for its small (parvi-) yellow flowers (-flora). Unlike *L. congesta,* the flowering stems of *Lesquerella parviflora* are elongated and sparsely leaved, arising from a central rosette. All of the Piceance Basin endemics could be adversely affected by large scale oil shale development. These three have been nominated for federal listing and the listing process is underway for two of them.

The Green River formation continues to yield new discoveries. Within the last year, *Penstemon debilis* (*debilis* meaning cascading growth form), was discovered on Mount Callahan in Garfield County. The excitement of discovering and describing this *Penstemon* for the first time fell to botanists Steve O'Kane (formerly with the Colorado Natural Areas Program) and John Anderson (U.S. Fish and Wildlife Service).

Raven Ridge is another very important location for Green River shale plants. Extending in a northwesterly direction between western Rio Blanco County and Uintah County, Utah, Raven Ridge provides habitat for four Green River shale endemics. Two of these are quite rare. Both Graham's penstemon (*Penstemon grahamii*) and White River penstemon (*Penstemon scariosus* var. *albifluvis*) are candidates for federal listing. The pinkish lavender flowers of Graham's penstemon seem over-sized for a plant only 2 to 8 inches tall. White River penstemon is less distinctive than Graham's penstemon with pale lavender to blue flowers.

Penstemon scariosus var. *albifluvis,* White River Penstemon

Ephedra buckwheat (*Eriogonum brevicaule* var. *ephedroides*), so named for its resemblance to Mormon tea (*Ephedra*), is relatively more abundant. Like the penstemons, however, it is restricted to barrens or sparsely vegetated desert shrubland habitats in Rio Blanco County, Colorado and Uintah County, Utah. A relatively widespread species that is nevertheless peculiar to Green River shale is also found at Raven Ridge. The dragon milkvetch (*Astragalus lutosus*), distinctive for its numerous small leaf-

lets, occurs on barrens as well as in depauperate desert shrublands and pinyon-juniper woodlands. Portions of this important botanical area have been designated as an Area of Critical Environmental Concern (ACEC) by the U.S. Bureau of Land Management (BLM). Through a cooperative agreement between the BLM and the Colorado Natural Areas Program (CNAP), Raven Ridge has been designated as a state Natural Area. Rare plant population studies have been established to describe the life history of these unique plants. Permission to visit the area may be obtained from BLM, White River Resource Area and CNAP.

The Arapien stickleaf (*Mentzelia argillosa* or *Nuttallia argillosa*) is interesting because it occurs with *Thalictrum heliophilum* and *Astragalus lutosus* on Green River shale barrens in the Parachute Creek drainage (Garfield County), yet in Sanpete and Sevier Counties in Utah it occurs in desert shrub and pinyon-juniper communities on the Arapien shale formation. This formation is characterized by high salt concentrations much like the Green River shale. Bright yellow flowers and smooth-edged leaves make this *Mentzelia* both beautiful and distinctive. The Arapien stickleaf is a federal listing candidate threatened by oil shale development in Colorado and gypsum extraction in Utah.

Another interesting barrens plant occurs not on the Green River formation but on scattered dark brown and gray clay lenses of the underlying Wasatch formation. DeBeque phacelia (*Phacelia submutica*) was discovered in 1911 near De-

Mentzelia argillosa, Arapien Stickleaf

Beque, Colorado by George E. Osterhout, an amateur botanist whose botanical forays from 1893 to 1930 contributed a great deal to our knowledge of the Colorado flora. This diminutive annual produces barely visible flowers from late April to late June and is frequently unaccompanied by other species, apparently because harsh soil conditions preclude habitation by all but the uniquely adapted phacelia. Like other geographic and geologically specific endemics, *Phacelia submutica* can be extremely abundant in very localized areas. Its entire range is contained within Garfield and Mesa counties. Threatened by oil and gas develpment and ORVs, the DeBeque phacelia has been nominated for federal listing.

Badlands Plants — Desert Jewels

Perhaps this whirlwind barrens tour will open the eyes of some to the extraordinary world of 'badlands' plants. We are fortunate to have so many 'jewels of the desert' within the boundaries of our own state. The shale formations described here are by no means the only ones conducive to development of barren land plant communities. Follow your curiosity into the landscape. Barren land habitats come in all sizes and in many places, but the processes are often the same. Next time you traverse hostile terrain stop the car and have a look. The myriad adaptations of barren land organisms to their environment are a source of wonder and fascination. No doubt the tell-tale signs of human use will be nearby — an ORV track, a gas pad, a quarry. Some of our barren land plants represent national treasures. Many will increasingly rely on our wisdom and stewardship if they are to remain for our children and theirs to see.

If you are curious, but don't know where to start, contact the Colorado Native Plant Society (CONPS). Fun and informative field trips are conducted annually by the Society to interesting botanical areas around the state.

Search for Our Botanical Legacy in Rocky Mountain National Park

by the Kathryn Kalmbach Herbarium RMNP Crew

During March 1987 the Kathryn Kalmbach Herbarium staff of Denver Botanic Gardens received a contract from the National Park Service to conduct a park-wide general flora and rare plant survey of Rocky Mountain National Park (RMNP). Our task was to document the location of any rare plants encountered by collecting voucher specimens (if population size warranted this), by map location and by photograph. Collections were also made of plants previously undocumented or recorded only once in the RMNP herbarium. With over 400 square miles of parklands to explore, it was evident that, at best, we could only provide a shotgun approach to the survey. From the outset of the project, the monumental proportion of our job directed us to our individual pursuits immediately.

None of the plant specimens collected in RMNP by explorers before the late 1800s are in the RMNP herbarium. John M. Coulter and George Everett Osterhout worked within the current Park boundary but their specimens were given to other herbaria. The bulk of the RMNP herbarium collection was contributed by Ruth Ashton Nelson, 1896-1987, who devoted much of her life to the flora of RMNP. Other recent day collectors who made significant additions include John and Margaret Douglass, Bettie Willard, William A. Weber, Dale McNeal and Robert K. Peet. Altogether they documented approximately 820 plant species for RMNP. Background research demonstrated that most of these records had come from relatively accessible areas and that vast sections of the Park had never been explored.

Herbarium members, Mary Edwards, Velma Richards, Peter Root, Janet Wingate, and Loraine Yeatts were actively involved in the field work, each lending enthusiasm, energy and expertise in a specific area of interest.

Loraine Yeatts was the principal investigator-coordinator for the project doing much of the research on former collection locations and pinpointing specific areas to be investigated in the summer's survey. As experienced backcountry backpackers, she and her husband Dick assumed the task of exploring some of the remote and least accessible locations in the Park. Also an expert photographer, she documented the rare and otherwise interesting species on film.

Peter Root, who has studied ferns around the world, investigated likely habitats in search of new ferns and allied species and new locations for the known non-flowering vascular plants in the Park.

Janet Wingate, who has taught classes and workshops and developed identification keys for grasses, concentrated her efforts in documenting the myriad grass species so often overlooked. She and her husband Hugh also found many new species in the "tourist" areas of the Park.

Velma Richards and Mary Edwards, both with experience in conducting floral surveys, specifically on the montane Walter S. Reed Botanic Garden of DBG and at Florissant National Monument, took on the task of documenting the species present on the alluvial fan in Horseshoe Park.

Also lending expertise to the project was Dr. William A. Weber, curator of the Herbarium of the University of Colorado, who verified the identity of all species collected as well as provided a catalog of specimens already in the Park herbarium.

Les Shader, a KKH volunteer from Fort Collins, prepared the computer data base, the final document submitted to the Park Service for their records and use.

Pteridophytes (Ferns and Fern Allies)

by Peter Root

The ferns and similar plants sometimes called fern allies are often overlooked because they lack flowers. They reproduce with very small spores which can be carried great distances and sometimes produce populations isolated from the main range of the species. Colorado has several examples of these isolated populations called disjuncts.

The spreading wood fern (*Dryopteris expansa*) is an example of a disjunct in the Park. It has been known from Dream Lake and two other locations for many years. The nearest known populations to these are in the Yellowstone Park area of Wyoming.

The study revealed this fern at four other sites in the Park. Three of these are in the Loch Vale-Glacier Knobs area and further investigation may show that they are connected. Near Glacier Falls this attractive fern in all sizes occurs along trails used by trout fishermen. Farther up Loch Vale a large group of wood ferns can be seen from the well-traveled trail. It is curious that these plants have been overlooked. Perhaps this is a species that has recently arrived in the Park and is now occupying suitable habitats near its original site.

The moonworts are a group of little known ferns found in the Colorado mountains. They are hard to see because they are small; but sometimes, when one small plant is found, a careful search will reveal many plants of several species nearby.

During the summer's study three species (*Botrychium lunaria, B. minganense, B. echo*) were added to the Park flora. It is interesting to note that they were almost always found along roads and trails. Where did they live before man disturbed the soil and vegetation? Perhaps they grew in avalanche tracks or burned areas. We are just beginning to find and identify these curious plants. Much work is still to be done before we understand their distribution and ecology.

Dryopteris expansa, Spreading Wood Fern.

Moraine Park and Other High Use Areas

by F.H. and Janet Wingate

Rocky Mountain National Park is a vast area whose vegetation extends from the montane through the alpine zones. Much of this area is accessible only through long treks on foot, often over steep and difficult terrain. On the other hand, several areas are easily accessible either by car or through short hikes, and these areas are therefore subjected to heavy use during the height of the tourist season. Although botanizing the high use areas lacks the sense of adventure and exploration of the remote hinterlands, the resultant floristic studies were equally important to Park management.

Moraine Park, Wild Basin, Sprague Lake and Bear Lake were a few of the high use areas we visited during the summer. Some infrequent plants found in these areas were the wire lettuce (*Prenanthes racemosa*), a speedwell, (*Veronica scutellata*), the wood-reed (*Cinna latifolia*), and a rare sedge (*Carex buxbaumii*). New species records were easily added to the list with three to six new records found during each trip to the field, yielding 60 new records for the summer. A third of these plants were grasses (Poaceae). As spring passed into summer and fall, a continual change in floristic aspect occurred in Moraine Park.

Carex buxbaumii.

Newly flowering species appeared from week to week and new records were constantly being added. We realized early on that even if our weekly sojourns into new areas proved unproductive, we could always close out the day in Moraine Park with an excellent chance of encountering something new.

Moraine Park, in spite of being one of the most heavily collected localities in the Park's history, is a prime example of a high use area which yielded many undocumented species for the Park. It is a broad valley bisected by the meandering Big Thompson River, surrounded on three sides by roads, and criss-crossed by numerous footpaths. Several habitats are found here, from wet stream banks and marshes to dry areas. Disturbed sites along trails produced several undocumented species including many introduced weedy forms. New records encompassed plants from the showy to the sublime; from the robust, brilliant red lousewort (*Pedicularis crenulata*) along the banks of the Big Thompson to the inconspicuous mudwort (*Limosella aquatica*) found in the muddy bottoms of shallow, drying ponds.

An additional task given [Janet] by Park management was the preparation of a reference collection of all grasses and grass-like plants in the Park. This entailed collecting and preparing an herbarium voucher for each species of Poaceae, Cyperaceae, Juncaceae, and Juncaginaceae in the Park. Over 90 plants, 60 of them from the alluvial fan in Horseshoe Park, were collected and processed during the 1987 growing season. We knew full well at the outset that this task was too monumental to be accomplished in one season and hopefully, this project can be continued in subsequent years to permit the completion of this reference collection.

Horseshoe Park Alluvial Fan

by Velma Richards and Mary Edwards

Horseshoe Park, at an elevation of about 8500 feet, was a lake during the most recent Pleistocene glacial times. Over millennia this filled in to form a relatively flat park area, some three miles long and never more than a half mile wide. Through this, Fall River flows. The tight horseshoe meanders of the river in the lower portion of the area give the Park its name.

The upper and narrower section of the Park had developed into a mature open ponderosa pine forest on its northern edge with grassy meadow areas, aspen groves, and some lodgepole pines downslope. A more riparian vegetation including willow and alder grew in the wetter areas.

Roaring River, arising from Crystal Lake at an elevation of about 11,500 feet, flows into Lawn Lake where an 80-year-old earthfill dam reduced its flow down the steep valley to its confluence with Fall River. Here it had been described as a gently bubbling stream — hardly resembling a roaring river.

On July 15, 1982, this was dramatically changed by the flood that resulted from a break in the Lawn Lake dam. Roaring River became a raging torrent bringing down tons of earth and debris and depositing it in the basin below. Fanning out from the base of Horseshoe Falls, this alluvium became the location for a significant part of our summer's work.

In addition to the general survey assignment, the Park Service asked us to prepare a working collection of all the species on the alluvial fan. On the surface this appeared to be one of our more mundane tasks; but the chance to look closely at revegetation of a denuded area and the discoveries of atypical species piqued our interest.

The alluvial fan in Horseshoe Park as it appeared in 1984.

1. Horseshoe Falls.
2. Roaring River.
3. Open ponderosa pine forest.
4. Pond formed by flood deposits damming Fall River.
5. Fall River. Note how it becomes a single channel stream downslope from the fan.
6. Braided stream.
7. Road.
8. Undisturbed meadow.

In the first summers following the flood, counts showed thousands of willow seedlings per square meter on portions of the fan. Although only a small percentage of the seedlings survived, by the summer of 1987 many had grown a foot or more and were found throughout most of the fan. Other species conspicuous by their abundance included the apple-green arctic pearlwort (*Sagina saginoides*), the toad rush (*Juncus bufonius*) ranging from an inch to a foot tall — all in bloom, and two species of willow-herbs (*Epilobium saximontanum* and *E. brachycarpum*) releasing their tufted seeds to the wind to produce a plentiful crop for another season. All of these were growing with their feet in the mud.

To the casual observer much of the alluvial fan, from boulder fields to flat expanses of gravel and sand, appeared barren with only dead tree trunks dotting the landscape. It was there that, each time we worked, we collected new species until the day ended. Most species were not present in abundance; rather, diversity characterized the area.

Although the majority of plants on the fan were those one would expect to find in a montane park, there were some exciting surprises. Plants typically of the tundra were discovered growing on flat expanses of gravel or at the foot of a boulder; we found buns of moss-pink (*Silene acaulis*), two alpine sandworts (*Tryphane rubella* and *Lidia biflora*), sibbaldia (*Sibbaldia procumbens*) and alpine sorrel (*Oxyria digyna*).

The highlight of the summer's work on the fan was the discovery of a rare and unique monkey-flower (*Mimulus gemmiparus*) growing at the edge of small rivulets with its roots just below the surface in the thoroughly saturated gravel. It was believed to be restricted to massive sloping granite outcrops with surface seepage water.

A few bright yellow blossoms drew attention to a cluster of these tiny plants growing, with little competition from other species, near a pair of dead

Mimulus gemmiparus, a rare Monkey-flower.

lodgepole pines. A closer look revealed that this was no ordinary monkey-flower. At the base of each leaf blade was a 2-3 mm long petiole modified to form a pocket containing a structure within which was a dormant embryonic shoot. This whole unit falls from the mature plant and in due time produces a new plant — indeed a unique method of reproduction.

This rare species was known only from three other locations in Rocky Mountain National Park and one location in the Tarryall Mountains. Finding it here on the alluvial fan, which was formed from deposits from the Roaring River drainage, indicates that there was at least another undiscovered location where it grew before the flood.

Each of the field participants worked on the fan collection project, some more than others, depending upon available time from other needed areas of the survey. From this limited acreage 206 sheets with plants identified, mounted and labeled were prepared for Rocky Mountain National Park Service. About 25 of these collections were of species previously undocumented for the Park. We know that there are other species here that we did not discover or did not collect given our time constraints. It will be interesting to return in another year to see what we missed or what new arrivals have taken up residence on the alluvial fan in Horseshoe Park.

Backcountry

by Loraine Yeatts

With visions of inadequacy based on the reputations of those who preceded us, I accepted the responsibility for reaching some of the remote and relatively inaccessible areas in RMNP. My husband Dick, acting as companion, assistant and sherpa, carried an 8-pound plant press and extra camera gear in addition to the usual necessities which allowed us to spend up to five days in the backcountry on each of three trips.

Certain areas in RMNP receive additional protection from human exploitation by being designated as Research Natural Areas (RNA). No camping is permitted within their boundaries, making the interior portions inaccessible to the average day hiker. We were issued a special research permit which allowed us to camp in the West Creek and Paradise Park RNAs. The third area we visited, the Forest Canyon drainage, is open to camping but equally difficult to access.

Each of these special sanctuaries shared common attributes but each is also characterized by unique features, making the last visited as interesting as the first. All the drainages encompass the elevational variety of the montane, subalpine and alpine plant zones with much land clothed in dense subalpine spruce-fir forest. Signs of human disturbance and developed trails were lacking, with only occasional snatches of animal paths to facilitate our passage.

The rich organic duff of the forest floor provided a nurturing environment for a host of plants normally considered infrequent to rare. Some members of the orchid family, which I had never seen before, such as little yellow coralroot (*Corallorhiza trifida*), were locally common; and heart leaved twayblade (*Listera cordata* ssp. *nephrophylla*) was abundant and widespread forming an extensive ground cover in local areas. I spent much time searching for the *Listera's* rarer relatives. *L. borealis* and *L. convallarioides,* to no avail. Eventually I was rewarded with the uncommon pink form of *L. cordata* intermingling with the white form. Stems of stiff club moss (*Lycopodium annotinum*) waving tiny club-shaped spore cases scrambled like caterpillars over damp duff and moss colonizing large areas. I thought this to be a relatively rare plant but now realize that only its habitat is rare.

Gymnocarpium dryopteris, Oak Fern.

Another treat was the abundance of ericads, members of the heath family, which shared their glories with me throughout the growing season. One-sided wintergreen (*Orthilia secunda*), wood nymph (*Moneses uniflora*), a myriad of pyrolas (*Pyrola minor, P. chlorantha, P. rotundifolia* ssp. *asarifolia*) and pipsissewa (*Chimaphila umbellata*) lightened the somber forest mood. The symphony green, in all its cadences, restored childhood memories of a Midwestern forest preserve forgotten in the muted greens of our semi-desert climate.

Chrysosplenium tetrandrum, Golden Carpet, a saxifrage.

A. *Moneses uniflora,* One-flowered Wintergreen. B. *Pyrola asarifolia,* Swamp Wintergreen. C. *Orthilia secunda,* One-sided Wintergreen.

Unlike the other areas we explored, West Creek is characterized by a diverse forest of ponderosa pine (*Pinus ponderosa*), lodgepole pine (*Pinus contorta*), douglas fir (*Pseudotsuga menziesii*), subalpine fir (*Abies lasiocarpa*), limber pine (*Pinus flexilis*) and Engelmann spruce (*Picea engelmannii*), each locally common and often intermingling. The lower elevation forest has been ravaged by disease and old burns, allowing dense shrubby thickets to invade. Briar patches of currants (*Ribes montigenum* and *R. lacustre*) and red raspberry (*Rubus idaeus* ssp. *melanolasius*) made travel tough. Even animals must have avoided the lower part of the canyon as their trails were not evident here. A rather rare saxifrage, golden carpet (*Chrysosplenium tetrandrum*), seen nowhere else, was abundant in this drainage, carpeting the mossy stream-side from West Creek Falls to timberline. When we observed it at the end of June most of the stems held calyx cups of tiny red fruits waiting to be planted by the wind.

The Paradise Park drainage could be best characterized by limited floral diversity. The relatively gentle valley floor is a series of interconnecting willow carrs interrupted by dense, mature spruce-fir forest where the valley gradient increases. Here I experienced an awesome

sense of remoteness — time in suspension — the heaviness of a climax landscape undisturbed since the last glacier scoured the valley. Perhaps five days of mostly gloomy skies contributed to the mood but the area left an indelible impression of wilderness a century ago.

The marvelous diversity of ferns throughout the Paradise Park-East Inlet loop we traveled enhanced my fern education immensely. Huge clumps of holly fern (*Polystichum lonchitis*) blanketed a very steep grassy slope and clung to crevices on the adjoining cliff. It had only been found in RMNP once previously. Oak fern (*Gymnocarpium dryopteris*) textured the rotting duff of the forest floor, forming large colonies in several locations. Alpine ladyfern (*Athyrium distentifolium*) was common on talus slopes near timberline. Ladyfern (*A. filix-femina*), rock brake (*Cryptogramma acrostichoides*), Rocky Mountain woodsia (*Woodsia scopulina*) and brittle fern (*Cystopteris fragilis*) were all common in their appropriate habitats.

Concept of rarity

In spite of the large number of plant species known to occur in RMNP, the shotgun approach to the survey has left large portions of the Park untouched. Even in areas supporting the largest number of plant records, only a few collecting days are represented. Areas of prime and diverse habitat should be explored regularly throughout the complete growing season. Only then can we begin to discuss the validity of plant rarity within the Park boundaries. Due to the opportunity to explore West Creek, Paradise Park-East Inlet, and Forest Canyon, I keenly sensed the value of large, pristine habitats preserved intact, undisturbed and rarely visited by humans. The thrill of discovering plants I had never or seldom seen made the effort involved worthwhile. In some cases, these plants formed ground covers in situations which allowed their climax development. Plant rarity seems to depend on two factors: first, a plant's growth requirements restrict it to a very narrow ecological niche; second, this niche is itself restricted, either naturally or due to disturbance. Thus I observed that in parts of RMNP some rare plants become abundant when their preferred environment is large.

The essence of a summer's work

To assess the value of our summer survey is difficult. The value to each of us personally was immeasurable — an opportunity to immerse in the beauty of wilderness and to revel in a restored sense of discovery and wonder.

In terms of numbers, collectively we added to RMNP herbarium 90 new records and 82 species which had been documented only once before. Twelve new sites for rare plants or plants of special concern were documented. A comprehensive working plant collection yielding 206 species was made for the Horseshoe Park alluvial fan. Also, a grass and grasslike working plant collection was begun with 95 voucher specimens. These latter collections are available for use by researchers working on various projects in the Park.

We believe that a great deal was accomplished during 1987. That much remains to be done, however, is obvious. Only a small fraction of the thousands of acres within the Park were investigated. For example, we were unable to progress to the western side of the Park with its Colorado River drainage area until much too late in the growing season.

A comparison of the species included in Ruth Ashton Nelson's *Plants of Rocky Mountain National Park* and the inventory (prepared by William A. Weber) of RMNP collections in the herbaria of the Park Service and the University of Colorado suggests that many species which undoubtedly occur within the Park are as yet undocumented. Hopefully we will be able to document many of these in subsequent field seasons if the Park Service continues the project in the future.

EXOTICS OF COLORADO

Bleeding Heart, *Dicentra spectabilis*

by Helen Marsh Zeiner

In May of 1847 a delightful garden plant bloomed for the first time in England and immediately became so popular that it spread like wildfire into every English garden.

This lovely new plant was bleeding heart, *Dicentra spectabilis* Lem., introduced from Japan in 1846 by Robert Fortune, an official plant collector for the Royal Horticultural Society. He found this charming plant in full bloom on the Island of Chusan and brought it back to the Royal Horticultural Society. Previously it had been known only from herbarium specimens. From the Island of Chusan he also introduced weigelia (*Diervilla rosea* Lindl.), and the Chusan daisy, a large, loose-flowered *Chrysanthemum* species from which pompon chrysanthemums were developed.

Fortune made four visits to China and Japan and brought back to England 190 new species and varieties; of these about 120 were new to English botanists and horticulturists, while the others had been known only from herbarium specimens.

By 1878 the bleeding heart had become such a favorite garden plant that its gracefully drooping racemes and heart-shaped pink flowers had become familiar as a wall paper pattern.

Bleeding heart, also known in earlier days as lyre flower and lady's locket, is symbolic of old-fashioned gardens but has never lost its popularity and, today, is a traditional favorite plant for spring and early summer bloom in shady borders. Its rosy red, heart-shaped pendant flowers are borne along gracefully arching floral stems. The two rosy outer petals are slightly united into a heart-shaped corolla about an inch long; the two inner petals are white and protruding.

New varieties of *Dicentra spectabilis* have been developed with flowers ranging from pink to red. A white-flowered variety has long been known; but, even though improved, it has never become as popular as the rose-flowered varieties.

In recent years a dwarf bleeding heart, *Dicentra exima* Torr., has become increasingly popular. It is also called fernleaf or plumey bleeding heart because its foliage is much more finely cut than that of *Dicentra spectabilis*. They are mostly 1-1½ feet high, contrasted with 2 feet for *Dicentra spectabilis*. The dwarf bleeding hearts will bloom from spring into early fall.

Bleeding hearts belong to Fumariaceae, the fumitory family with five genera and 150 species. Some authors combine it with Papaveraceae, the poppy family. The genus *Dicentra* is composed of 15 species of perennial herbs in North America and Asia. The petals are slightly united into a heart-shaped or two-spurred corolla. The word *Dicentra* is de-

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Helen Marsh Zeiner, Ph.D., honorary curator of Kathryn Kalmbach Herbarium at Denver Botanic Gardens, writes "Exotics of Colorado" as a regular feature of *The Green Thumb*.

Dicentra spectabilis, Bleeding Heart.

rived from the Greek and means two-spurred. The species name *spectabilis* is from the Latin and means visual or remarkable — most appropriate for bleeding heart.

Two eastern woodland flowers, Dutchmans breeches and squirrel corn, belong to the genus *Dicentra* and their flower shapes clearly show their relationship to bleeding heart. Both delicate white-flowered charmers grow in the rich leaf mold of deciduous forest floors.

Golden smoke, *Corydalis aurea* Willd., a Colorado wildflower belonging to the fumitory family, is seen in early spring on the plains and lower foothills, often on road cuts. It extends into the montane where it blooms later.

Bleeding heart is not ancient enough to have become a part of English legend, but there is an old Chinese folk-tale set 2000 years ago in the Han Dynasty. It tells us that a caravan was ready to set out carrying treasures to exchange for those of western Asia, when its leader suddenly became ill. A young man named Chang was chosen to replace him. Chang was delighted by the honor, but his pretty young wife worried for his safety because bandits were always a threat.

She sat under a weeping willow and wept until a servant suggested that she should consult a sorcerer who could look into the distance and see her husband with the caravan and know that he was safe.

The sorcerer gave her a magic necklace of lumps of rose-red coral. If she wore it against her heart, each morning just as the sun rose she could see her husband. Weeks went by, and each morning she saw Chang and knew that he was safe. Then one morning she saw Chang and the camel boy fighting with a horde of bandits. As she watched, her husband was beheaded.

Frantic with grief, she threw herself over a cliff. Her servants sadly climbed down to recover her body; but all they found was the coral necklace which had been turned into a flower — rose-red bleeding hearts strung on a stem.

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New Field Guide for Amateur Botanists

It's here! The all-new Eighth Edition of M. Walter Pesman's Meet the Natives *so popular with amateur field botanists for over 40 years.*

Five Denver Botanic Gardens volunteers of Kathryn Kalmbach Herbarium, all professional botantists, have worked for more than a year to produce this edition which should be more easily used than ever before. As in earlier editions species are listed within altitudinal zones. Within zones, division is first by plant form — tree, shrub, herb — and then by flower color. The 445 species described are those most commonly seen throughout the region.

New for this edition is the arrangement by families within each color category. The revising committee felt that this arrangement would be an additional help for the amateur trying to become familiar with the flora of the region because of the similarity in flower structure and other features within a plant family. Groups treated separately include vines, water plants, and ferns, horsetails and spikerushes.

Line drawings along page margins emphasize identifying characteristics. Many of these drawings are reductions of the treasured works done by Emma Ervin; some are Pesman's originals; new ones have been drawn by Janet Wingate, a frequent contributor of botanical illustrations for *The Green Thumb*. For the first time most of the words listed in the section "Botanical Terms Explained" are illustrated with line drawings done by Dr. Wingate. Enhancing the cover are three exquisite color photographs from Loraine Yeatts' collection.

Popular sections that have been retained are: "What are Life Zones?"; "Elevations of Towns, Peaks, Passes, and Parks"; "What Do These Scientific Names Mean?" The informative chapter "About Flower Families" as well as a list of references useful in flower identification should be helpful to both the novice and the experienced wildflower enthusiast.

Meet the Natives, published by Pruett Publishing Company of Boulder, will be available for the 1988 wildflower season. It may be purchased from Denver Botanic Gardens Gift Shop and other leading bookstores.

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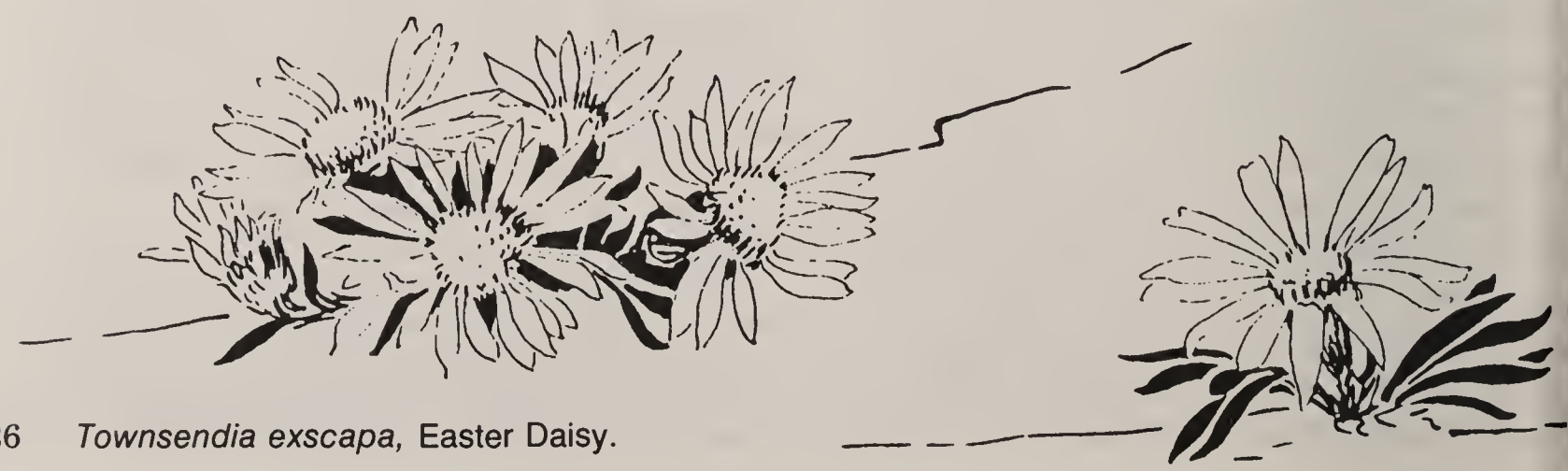


Townsendia exscapa, Easter Daisy.

Leucocrinum montanum, Sand Lily.

About Emma Armstrong Ervin

Emma Armstrong Ervin (1874-1957) was a well-known artist during the first half of the present century. The Ervins spent many weeks each summer at their cabin near Longs Peak where Emma was inspired to produce many landscapes in oils, especially of aspen scenes. A reproduction of a striking view of Longs Peak appeared on postcards published and sold by Enos Mills, early Colorado naturalist and owner of the famous Longs Peak Inn.

About 1914 Emma began her watercolors of Colorado wildflowers. During the next 20 years the collection grew to more than 200 accurate botanical paintings. She painted from fresh flower specimens collected near her cabin or brought to her by friends. Painstaking, detailed drawings of the flower parts were also added. These sketches she used as motifs in conventionalized designs and patterns for book plates and illustrations — even patchwork quilts.

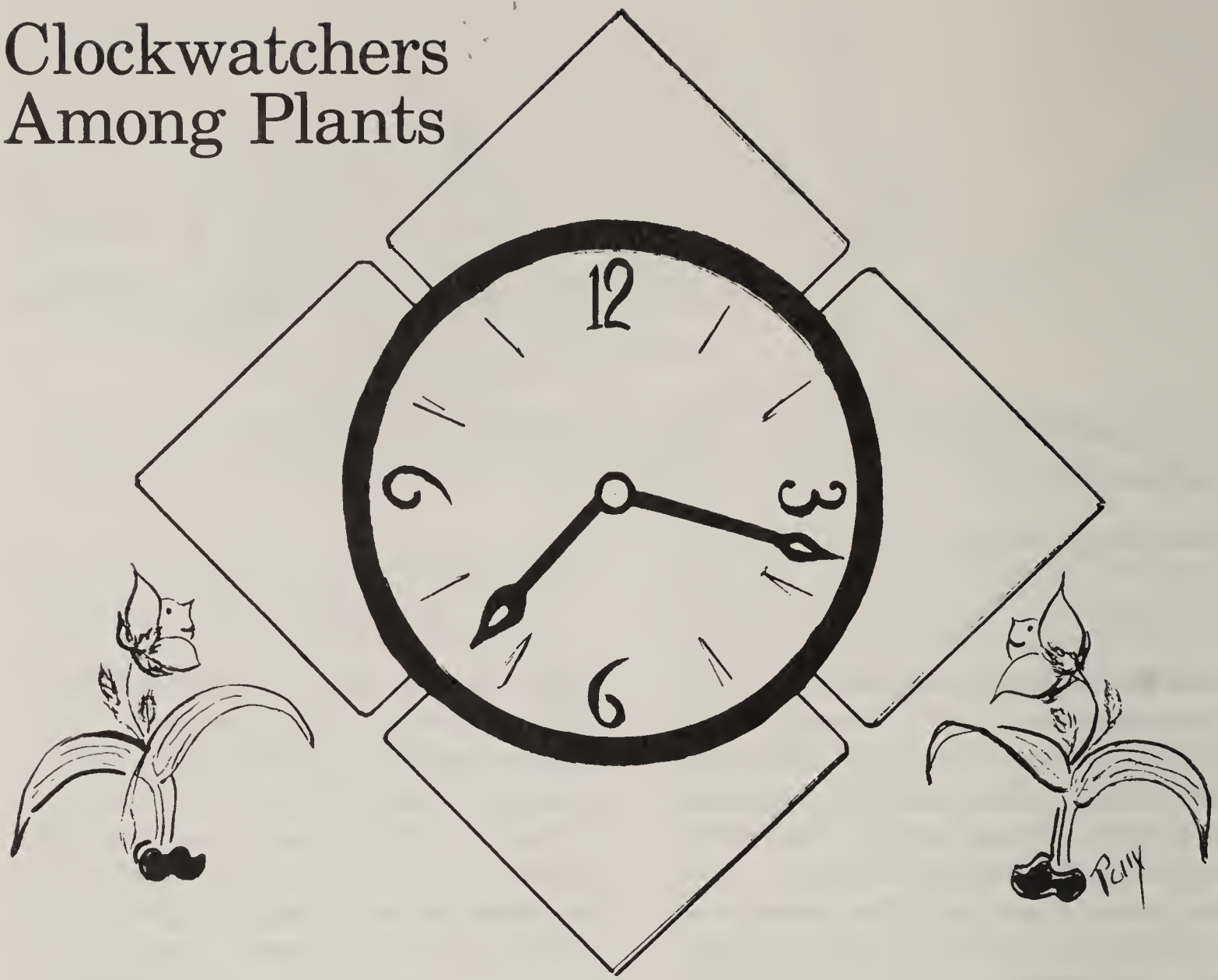
Her ambition was to prepare an illustrated flora of the wild flowers of Colorado using her watercolors. However, printing illustrations in color was a costly process, and no publisher was interested in producing such an expensive volume that would have limited distribution.

These treasured paintings were purchased by Gladys Cheesman Evans for the Colorado Forestry and Horticulture Association, the predecessor of Denver Botanic Gardens. Later they were mounted and bound into five volumes and are now displayed in the Helen Fowler Library at the Gardens.

Two hundred line drawings for the new *Meet the Natives* have been prepared by Janet Wingate from Mrs. Ervin's original watercolors.

Information included here is taken from "Emma Armstrong Ervin (1874-1957)" by Katharine Bruderlin Crisp, *The Green Thumb* 18(7):231-233. Ed.

Clockwatchers Among Plants



How Rocky Mountain Wild Flowers Tell the Time of Day

by M. Walter Pesman

"But I know there is a lot of blue flax here;
I saw it with my own eyes just yesterday morning!"

The time was four o'clock in the afternoon; only after diligent search did we manage to find the neat little seedballs and the slender stalks of the flax that had been so conspicuous with their blue flowers in the forenoon. *Linum lewisii,* blue flax, is merely one of the flowers that are open in the morning but not in evidence after two o'clock, or thereabout. In this case it drops its petals which dry up quickly thereafter.

Tradescantia occidentalis, spiderwort, is another blue flower that plays hide-and-seek in the afternoon. Conspicuous as it is with its three petals, ranging from a deep blue to a reddish purple, you can only recognize it in the afternoon by its floppy, grass-green leaves. Of course, if you break its stem, there is no mistaking its slimy sap that draws out in strings from both broken edges.

As if blue were the trademark for these early morning lovers, there is still another, *Cichorium intybus,* the common chickweed, that found its way here from Europe. It is a beautiful immigrant showing hundreds of light-blue star flowers in the forenoon. Like the dandelion, it has nothing but strap flowers, lacking the central heart of the sunflower type of

Spiderwort.

composite. The fact is that it has given its name to the entire tribe of *Cichorieae,* which can be recognized by having strap flowers only and milky sap. (Also, these are called ray flowers.) From Europe it brought its habit of going to sleep around eleven o'clock not to open again until the next day. I wish I knew whether it makes up for this afternoon nap by opening very early in the morning, but I have never checked its early rising.

About the same time in the forenoon, *Tragopogon porrifolius,* the oysterplant (also called salsify) closes. It belongs to the same chicory group with strap flowers and milky sap, but comes in either yellow or violet-purple. It is the plant that later on displays the baseball-sized, beautiful seedball, like a huge dandelion puff. Yes, it also comes from Europe; there, as here, it is cultivated for its root which furnishes the good vegetable oysterplant.

Morning glories and water lilies have a similar habit of calling it a day before the sun gets to the south. A good deal of scientific observation is desirable to find out just what makes the mechanism function. Light intensity seems to be one of the factors involved; perhaps temperature plays a role even though the main mechanism seems to be a periodicity that the plant inherits in its seed. Without using such a big word, what the plant scientists mean is merely that light, temperature, or other factors may have something to do with it, and may make a minor change, but you can't stop a regular plant habit. Perhaps we should not say that hell and high water can't do it but rather cloudy heavens and rainy weather.

Just the opposite daily habit is indulged in by such flowers as *Mentzelia,* evening star flowers, and by many evening primroses. Many of them are night

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M. Walter Pesman, author of *Meet the Natives* and *Meet Flora Mexicana*, was preparing yet another manuscript before his death in 1962. The manuscript for the book was given by Mrs. Pesman to Mrs. Katharine Crisp, then chairman of the Editorial Committee of Denver Botanic Gardens. A series of articles using excerpts from this manuscript were printed in *The Green Thumb* in 1966 and 1967. The article above appeared in the July/August 1967 issue of the magazine [24(4):111-116].

The accompanying art is the late Polly Steele's work and Janet Wingate's conversion of Emma Ervin's watercolor of spiderwort.

Morning Glory.

Evening Primrose.

bloomers, opening up at five or six o'clock in the evening, and closing some time in the forenoon. Appropriately enough, they are all a dazzling white or bright yellow, easily seen in subdued light.

It is an exciting experience, watching, for instance, the blossoms of an upright, yellow evening primrose unfolding in the evening. They open so suddenly, they almost "pop". Very shortly thereafter the evening moths come visiting them, some of which are a gorgeous color themselves.

Unforgettable in my memory is an experience with *Mentzelia decapetala*, the large beautiful evening star. I had picked a sturdy stalk topped by a number of large buds. There were many of them around the city of Pueblo. Mainly to keep them from wilting, I had put them in my hotel washbowl, then forgot about them. At seven-thirty I suddenly became aware of a delightful fragrance pervading my room. There, in the washbowl, three of these gorgeous, ten-petaled blossoms had opened — as striking a sight as any night-blooming cactus. They were easily 4 to 5 inches in diameter and of a satiny white.

Other evening star flowers are yellow and open around five o'clock in the afternoon; whole mountain sides may be transformed by them at that time.

How easy and tempting it is to jump at conclusions. Seeing a flower open in the evening makes us think it is a night bloomer depending upon night flying insects, such as a sphinx moth, to be pollinated. The common, white evening star flower seemed to be an illustration.

Since I had been charmed by its royal brother, *Mentzelia decapetala,* the large evening star flower, which had opened in my hotel room, I took it for granted that *Mentzelia nuda,* the common evening star flower, would be a regular night-bloomer.

So, I took a branch of opening buds to serve as a table decoration for supper. It was beautiful — opening around five o'clock. But at eight o'clock we noticed that it had gone back to sleep. We sympathized with it, thinking that the strong lamplight had fooled it into thinking (does a flower think?) that day had come. We took it back into the outside darkness, hoping the flowers would re-open. It did not work.

Then followed a series of scientific experiments. Before long we found that a cut branch was undependable, especially if placed in unnatural surroundings. There was nothing to do but watch a plant in the open in its natural setting.

The first part of the experiment was not difficult: flowers opened up regularly between five and five-twenty p.m. Bees came to visit them on their late evening flights — a lot of bees.

Then came the question: what would pollinate them during night-time? The first nightwatch was a failure; it rained. Something went wrong the second night; we could not find the plants in the dark. The third time made us wonder. At nine o'clock there were no open flowers. Had we misjudged the buds that afternoon? More night visits. At last we had to admit that *Mentzelia nuda*'s night life is a very short one (happy, we hope). Opening at five, the blossoms show their full beauty for only a few hours; around seven-thirty shop is closed and any flowers that have had no visitors must wait until the next

evening. Our first observation in the lamplight was the correct one and, evidently, artificial light was not the contributing factor we had imagined.

It seems that, in this case at least, the flower acts upon a rhythmical impulse, rather than upon a certain intensity of light or a certain temperature, as might be imagined.

Much information needs to be gathered about the different evening primroses and their day-and-night habits. Some are called morning primroses — are they merely late closers or do they, perhaps, open so late in the evening that we overlook them? One of these is the striking *Oenothera caespitosa* ssp. *macroglottis,* fragrant morning, of the foothills certain to attract attention on east or south slopes in early forenoon. Their four white petals gradually turn from a brilliant white to an interesting pink as the morning progresses. Finally, nothing but a reddish pink spot remains nestled among the rosette of the dark green leaves.

Acquiring this reddish tinge upon wilting seems to be a common habit with this flower. Where the foundation is a bright yellow, as is the case with *Oenothera brachycarpa,* golden evening primrose, the resulting color is apt to be a striking orange. It draws great attention where it grows in the plains and foothills. A similar orange "wilting color" is found in its more delicate cousin *Calylophus lavandulifolia,* puckered sundrops, another member of the evening primrose family.

Morning glories may not only tell the time of day but are so outspoken about it, that people have attached the habit to the name. (Incidentally, that pink wilting color occurs with them as well.)

Four o'clocks proclaim their afternoon habits by their name. There is a whole family of them; even the botanical name, Nyctaginaceae, has incorporated the Greek word *nyctos* (night) in reference to their nocturnal habits. Most of them, if not all, bloom from the afternoon until morning only. You can almost set the clock by their regularity.

A "flower clock"? Yes, that is just what our old, old friend Linnaeus, the Swedish botanist, outlined, and what William Bartram of the Schuylkill River Garden studied out, and what Dr. John McFarlane, Professor of Botany at the University of Pennsylvania, describes. Here are some of Dr. McFarlane's "Clock-marks":

Midnight to two-thirty a.m. — Night-blooming cereus in full glory.

Three a.m. — Amazon water lily is open.

Four-thirty a.m. — Virginia spiderwort is unfolding.

Five a.m. — Purple morning-glory opens; so does wild rose, Iceland poppy and blue chicory.

Six to seven a.m. — European water lily unfolds.

Seven to eight a.m. — Texas water lily, orange-red daylily, purple looking glass, yellow wall lettuce from Europe — all join the procession.

Eight to nine a.m. — Scarlet pimpernel, portulaca and marigold follow.

Nine to ten a.m. — Purslane, veronica, cinquefoil and Mexican water lily start blooming. At ten o'clock most water lilies are in full glory, excepting Zanzibar lily, which opens toward noon.

Ten-thirty a.m. — Bengal crimson water lily closes.

Twelve noon to four p.m. — Successive closing of water lilies, sow-thistle, potato, blue chicory, dandelion, California poppy, red hawkweed, purple pimpernel, finishing up with portulaca, bluebell and pink.

Seven p.m. — Grand show of many evening and night-blooming flowers opening.

The idea, therefore, of flowers telling the time of day is not new. But we, in the Rocky Mountain region, have a challenge to add our local information to that of Sweden and Quakerland. We can be pioneers.

In addition to the flowers mentioned in the first part of this article, we should call attention to *Tragopogon,* salsify, which "calls it a day" at about eleven o'clock in

the morning. No wonder a popular name has been attached to it: "Johnny-go-to-bed-at-noon." Both kinds, *T. porrifolius,* the oysterplant, with purple blossoms, and *T. pratensis,* meadow salsify, with pale yellow heads, seem to have the same sleeping and waking habits. Both can be easily identified at any time by the large, fluffy seed-heads which resemble those of a dandelion candle, only of brownish color and much larger.

Purple thistles (or at least some of them) are apt to open at the very time salsify goes to sleep. *Nuphar luteum* ssp. *polysepalum,* our yellow pond lilies, generally close in the afternoon to the great disappointment of mountain tourists who may only reach their high altitude at that time.

A word of warning may be appropriate here. It would hardly be safe to depend on these flower clocks for catching a train or timing a race. Too many extra factors enter in. Some blossons may just be sensitive to sunlight. In fact, I know of one dainty gentian, *Chondrophylla*, the moss gentian, which grows high in alpine meadows, that closes its funnel-shaped blue flower whenever a cloud passes over it. (It does likewise upon being picked.)

Other flowers should really be called living thermometers rather than time-tellers; their opening and closing have to do with a certain degree of temperature which, in general, corresponds to a certain time of day in nature. Others again are really hygrometers because they indicate the moisture content of the air.

Then there is the behavior due to a natural periodicty. No matter what happens, some flowers open at a certain time and close after a definite period has elapsed. On further study we are most apt to find a very real adaptation to the insect on which a particular flower depends for its pollination. Night-bloomers are almost sure to wait for night-flying moths; bees, as we know, do not work on a night-shift, so cannot be depended upon except by day-bloomers.

Night habits of leaves, on the other hand, seem to have to do mostly with internal conditions of the plant itself. A certain internal pressure of its sap, the amount of transpiration, perhaps even chemical changes in the sap may cause a leaf to "fold up."

A great many members of the pea family have leaves that go to sleep at nightfall — they might be depended upon for telling the time of day after six or seven o'clock. Poor things, what *do* they do in the polar regions where both day and night last six months each? Evidently our flower clock must be adjusted to different latitudes — yes, and to altitudes in the Rocky Mountain region. Oh, well, we might as well admit it once more: nature never could be successfully and neatly filed away in a hard-and-fast system.

As long as we are closing this topic on a less serious note, let us sound a final warning, that is, not be led astray too easily by names. Four o'clocks, morning glories and evening star flowers are really indicative in their names of their habits. But please do not be misled by the name into ascribing nocturnal habits to this group of plants. Nor expect wake-robin to have alarm clock proclivities, or accuse Shakespeare of alluding to a floral clock when he talks about "sweet thyme."

To put it very simply: these plants have no "horological proclivities."

"JUST A WEED" — INDEED!

I ASKED A SCHOLARLY TEACHER,

(FOR I'M A CURIOUS CREATURE):

"WHAT IS THIS PLANT THAT DIED?"

"OH, IT'S JUST A WEED," SHE REPLIED.

IT WAS WITH GREAT SURPRISE,

I BEGAN TO REALIZE,

SHE WAS BLIND TO THE BEAUTY BEFORE HER EYES.

THE PLANT I HAD IN MIND,

HAD THE LOVELIEST OF DESIGN,

YET SHE SPOKE WITH GREAT SCORN

OF BEAUTY ALIVE BEFORE SHE WAS BORN.

HOW ARROGANT TO PRE-SUPPOSE

IT IS JUST FOR YOU THAT EVERYTHING GROWS.

"JUST A WEED" — INDEED!

I LOVED THAT WEED.

— Gloria R. Barron

The Green Thumb

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Birches for the Front Range?

by Julia Andrews-Jones: An interview with Larry Watson

Are white barked birches no longer suitable for our Front Range landscapes? Although birch plantings have failed in many landscapes in recent years, a tour throughout the region confirms that mature birches carefully maintained are spectacular in the proper setting.

The most common are European white birch (*Betula pendula* Roth.), a large tree with graceful even branching and the cutleaf weeping birch (*Betula pendula* cv. Gracilis) with its pointed leaves and pendulous branches. Perhaps one of the trees most easily recognized by the general public, its grace and delicate light green color add significantly to the landscape palette. White birch was almost a signature of renowned landscape architect, S. R. DeBoer. Another birch known as canoe, paper or white birch (*Betula papyrifera* Marsh.) is often used in Denver and is recognized by its flaking bark.

For the answer to the question of suitability of birches for this area we turned to Larry Watson, respected local nurseryman. His answer follows:

Birches are cold hardy for Denver, Boulder, Colorado Springs and many other cities on both the eastern and western slopes of Colorado. They do not die because of the cold. My nursery experience has been that birches do well with the wide range of winter temperature variations. In other words the hot sun on the bark in winter does not harm them.

The problem is that birch has very specific cultural requirements. By understanding how birch grows in its natural environment, we can attempt to duplicate these conditions and be more successful in growing them.

Birches have a fibrous root system which grows along the surface and does not penetrate deeply into the soil. They grow in soils that are well drained, have a high oxygen content, are uniformly cool and high in organic matter. You can see why people with clay soils, that by definition are both low in organic matter and high in water holding capacity, can have problems getting birch to thrive. Many people will over-water in the summer, thus lowering the oxygen content of the soil, and not water at all during winter.

Let me tell about two incidents that happened when I worked at Western Evergreens nursery. In the 1960s we bought mostly cutleaf weeping birch bare root from out of state suppliers and potted them into containers for later sale. The soil mix with mountain peat was about 50 percent organic. One year I put these container birches under a water line that leaked whenever the pump was running. During summer the pump would be on 12 hours and shut off for 12 hours. So these trees were being watered for 12 hours and then the water would completely drain through the potting mixture in the 12 hours that the pump was off. These birches grew better and faster than any I have ever seen.

The other incident involved a customer. We know that birch will die if planted in heavy clay soil and overwatered. Therefore, we always told our customers to plant their birch half out of the

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Julia Andrews-Jones, graduate in landscape architecture from Iowa State University and a member of the American Association of Landscape Architects, has been in private practice for over 30 years.

Larry Watson, a graduate of Colorado State University, is a long-time nurseryman in this area. He was influential in introducing many natives and unusual exotics into Rocky Mountain landscapes.

ground and explained how important it was to add large amounts of peat moss to the soil. No one left the nursery with a birch without this lesson.

One day a man came into the nursery and asked me for birch. When I showed him where they were, he immediately selected seven trees — a big sale! When I started my lecture on how to plant birch trees, he broke in with "You don't have to tell me how to plant these trees." That statement made me very defensive about the possibilities of these seven trees surviving. Then he added that several years ago I had given him the lecture about how to plant birch half out of the ground. He related how he had done better than that. He did not dig holes but put them on top of the ground and backfilled around them with lots of peat moss in the soil. Then he added that he was the only guy in Westminster with live birch. He was buying the seven trees for his neighbors.

I think these two stories illustrate the cultural requirements of birch. The ideal seems to be to reconstruct the forest floor around them. This means planting birches in soil with a high organic content and planting high if the native soil does not drain. Then mulch heavily with some kind of wood mulch and even plant some type of ground cover, such as *Hypericum* cv. Hidcote (St. Johnswort), *Mahonia repens* (Oregon-grape), or *Euonymus coloratus*, over it which would catch all of the leaves possible.

In an attempt to duplicate the white bark of the birch, our native aspen *(Populus tremuloides)* is used. In my opinion they are a very poor substitute in a garden or well watered situation. Aspens are prone to disease, and there is a constant battle with the suckers that spring up everywhere. Birches with their graceful, even branching and delicate, light green color have a refinement that adds distinction to the landscape in the Front Range of Colorado.

We have two native species of *Betula*; both are very interesting in their own way. A major drawback for garden design, however, is their lack of a white bark. Western river birch *(Betula fontinalis)* is native to much of the Rocky Mountains and is found frequently along the water courses in the foothills. It is a large multi-stemmed shrub or tree to 40 feet tall with lovely dark cherry bark.

Bog birch *(Betula glandulosa)* is a shrub found from about 9000 feet to timberline in the Rocky Mountains. On Vail Pass it is 2-3 feet high; at timberline it is 12 inches. It acclimates to Denver and grows 5-6 feet tall. The very dark green leaves turn a brilliant red in autumn. At one time we had difficulty reproducing these birches, but we have learned much about them in the last 5-10 years. Since we learned to throw mist *and light* on the bare seed, we can produce more than we can sell — a nurseryman's malaise.

In the canyon above Chautauqua Park in Boulder is a birch that some people call grey birch *(Betula populifolia)*. In my own mind I think it may be a hybrid of *Betula fontinalis*. It may have greater tolerances for a variety of cultural practices. Work could be done to try to develop cultivars and hybrids.

The insect pest, bronze birch borer, has nearly destroyed the European white birch in eastern United States. It also has taken some toll in this area. Sometimes, I think, the borer is blamed when the true culprit is poor cultural practices.

It is very difficult to buy European white birch simply because no one is producing it. This has brought about the introduction of many Japanese birch varieties *(Betula platyphylla)*. We know very little about these varieties; they must be tested in this area. Testing new cultivars as well as species new to this area is certainly a needed function of the Botanic Gardens.

We should not turn our backs on the genus *Betula*. We should work with it, giving it the proper respect and care it requires and perhaps discover cultivars or hybrids that will be perfect for our soils.

Birches in Landscape Design

by Julia Andrews-Jones

Well designed landscapes do not just happen. There are relationships, principles of design, which are carefully manipulated in the process of designing. In landscape this process continues long after the architect has left the scene because plant material is never static, never finished. Pictures can illustrate these prinicples of design better than many words. How some of these relationships work to make landscapes visually delightful are illustrated here.

Birch with its particular characteristics makes a good subject; but other species of trees may be equally useful accents in a garden.

1. The white bark of a large birch *(Betula pendula)* is a focal point of this garden in the same way a piece of sculpture would be used. Contrast, another principle of design, is at work here. The dense shade helps to give the beautiful trunk significance.

2a. Proportion is one of the most difficult principles of design to illustrate. It is very subjective, but the unskilled eye is pleased when the parts are in proportion to each other. The eye is pleased by the proportion of footspace to this specimen birch. Compare this with picture 2b. This also shows the pendulous growth habit of *Betula pendula* which is a point of contrast with the plant material around it.

2b. The principles of scale and proportion become intertwined and are illustrated here in a negative way. The choice of birch in this site is questionable because it will probably never grow to the scale needed in this large, austere public place. It is not thriving because its cultural requirements cannot be met where foot traffic packs the soil over the roots. The pendulous habit over a pedestrian walk is a clue that scale and proportion are not working.

3. The smaller birch has a pleasing proportion to the tool shed at the back of the garden. The brown fence becomes part of the background so the tree's white trunk becomes an accent within the garden. If the tool house were colored, the birch would be further enhanced as an accent.

4. This small birch "woods" at the end of an open lawn rather than an individual specimen tree is the accent or focal point. The shade, denser because of the group, intensifies the contrast of the white trunks with the green grass. This woods defines the space of the open lawn (not shown). Note the two aspens *(Populus tremuloides)* at the rear of the woods. The bark of aspen does not have the definition and refinement that the bark of the brich has. The owner commented that he fights aspen suckers constantly.

5. The principles of proportion and scale are working well in this site. Could there be a more magnificent accent for a Denver parkway?

Colorado's Wetlands

by David J. Cooper

Most of Colorado's landscape features are familiar to us by name: the Front Range, Grand Mesa, South Park. Also, the environment of much of our state is familiar to us from our experiences with the prevalent vegetation: short grass prairie on the semi-arid eastern plains, sagebrush or Gambels oak shrubland and pinon-juniper woodlands in the semi-arid western valleys, ponderosa pine, Douglas fir and Engelmann spruce-subalpine fir forest on the mesic mountain slopes, and alpine tundra on the higher mountain summits. The concept of vegetation zonation along the altitudinal gradient is well-known to most nature lovers and careful observers. But streamside wetland ecosystems form continuous narrow bands extending from the high peaks down to the lowlands and flow right through the generalized altitudinal zonation of vegetation we know so well. While it is easy to place individual experiences with streams, rivers and lakes, wetlands do not fit neatly into the framework of altitudinal zonation and thus they are often overlooked as important landscape components.

Water is a critical limiting factor for plants in Colorado's dry and continental climate. Total precipitation in most areas is much less than the potential evaporation or evapo-transpiration. As a result the soils in most areas may be dry for a significant portion of the summer, limiting plant growth. In Colorado where rain and snow-melt water runs off into river valleys, into poorly drained basins or erupts as springs more water is received than can percolate through soils or be lost to evapo-transpiration. These areas have saturated soils which contain very little free oxygen. The roots of most plant species derive the oxygen they need for respiration directly from the soils. When soil saturation occurs for a significant portion of the growing season and free oxygen is absent from the soil rooting zone, this becomes a leading ecological factor controlling the species of plants that can occupy the site as well as the type of soils that form. Portions of the landscape that are characterized by abundant water and a lack of free oxygen in the soil during a significant portion of the growing season are wetlands; and plants living in wetlands have special adaptations which allow them to pass air down their stems to roots, or to undergo anaerobic respiration for periods of time.

Wetlands occupy less than 5 percent of Colorado's landscapes, yet they provide a

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David J. Cooper, Ph.D., is assistant research professor, Department of Environmental Sciences and Engineering Ecology at Colorado School of Mines in Golden.

Plant nomenclature follows Weber, W.A. 1987. *Colorado Flora: Western Slope.* Colorado Associated University Press. 530p.

number of very important ecological functions. For example, they are critical habitat for many animals, particularly waterfowl and other water birds, fish, amphibians and many insects. Leaves and stems from wetland vegetation adjacent to rivers and lakes may fall or be washed into the water and provide organic matter that supports the food chain in these aquatic ecosystems.

Wetlands in urban and agricultural areas are especially important in cleaning water. Wetlands remove sediment, heavy metals and other pollutants found in runoff. Bacteria that live in the anaerobic conditions of wetlands convert nitrates in runoff water to nitrogen gas which leaves the ecosystem. Wetlands have even been used as municipal tertiary water treatment systems in many parts of the country to remove nitrogen compounds from waste water. Another important wetland value is recreation. Fishing and hunting are obvious values; but also for non-consumptive recreational uses, the combination of land and water and the richness and variety of habitat make wetlands popular for botanists, birders and all nature lovers.

Types of Wetlands In Colorado

Colorado, with its wide range of elevation and habitat, supports a wide variety of wetland ecosystems. With regard to wetlands the state can generally be divided into four main physiographic environments: high mountains, foothills and canyons, intermountain parks and basins, and plains.

High mountain areas were glaciated during the Pleistocene epoch and much of the landscape has been shaped by glacial and periglacial processes. Glaciers have eroded valleys into broad, relatively flat bottomed and steep sided shapes and deposited terminal moraines which have dammed up some streams. Lakes were created in these dammed valleys and most have been filled in with stream carried sediment forming level surfaces. Most of these filled lakes occur between 8,000 and 10,000 feet elevation.

Melting of the high mountain snowpack in April through July saturates valley bottoms and many basins at the higher elevations are flooded for several weeks at this time of the year (figure 1). An important feature of the weather in Colorado's high mountains is the ex-

Figure 1. Fen dominated by *Carex aquatilis* and *Carex utriculata* in Big Meadows, Rocky Mountain National Park, is flooded for 4-6 weeks each summer. The abundant flowering plant is marsh marigold *(Psychrophila leptosepala)*.

tremely windy conditions during the winter which reworks the alpine snowpack creating deep snowbanks on the lee sides of hills. The melting of these snowbanks continues through the summer, long after the overall mountain snowpack has melted, and provides important base flow for streams, recharges ground water supplies and maintains soil saturation in high mountain wetlands.

Fast rushing highly oxygenated streams are usually lined with a profusion of very showy flowering plants including bluebells *(Mertensia ciliata),* brook saxifrage *(Micranthes odontoloma),* butterweed *(Senecio triangularis)*, bitter cress *(Cardamine cordifolia)* and cow parsnip *(Heracleum sphondylium* ssp. *montanum)*. Mosses also may carpet these streamsides. The very wet valley bottoms that are saturated for much of the summer season are usually dominated by swards of sedges, particularly *Carex aquatilis, C. utriculata, C. scopulorum, C. canescens* and others. Abundant flowering plants include marsh marigold *(Psychrophila leptosepala),* elephantella *(Pedicularis groenlandica)* and bistort *(Bistorta bistortoides)*.

Soils in these sedge dominated wetlands are anaerobic for most of the growing season, and decomposition of each years plant growth is incomplete. Dead leaves and roots accumulate forming peat; these ecosystems are true peatlands. Most Colorado peat is formed by sedges, not mosses, thus we have little "peat moss." Peat accumulates very slowly in Colorado, approximately 6 inches per thousand years! Thick peat deposits thus represent an extremely long period of time. Technically all of Colorado's peatlands are **fens** because much of their water source is surface runoff from mountain slopes and ground water which contains minerals, such as calcium, necessary for plant growth. True **bog**s have precipitation as their sole water source, occur only in more humid climates and are very nutrient poor. No bogs occur in Colorado because precipitation is too low and the climate too dessicating to support wetlands in landscape positions not supplied with abundant surface and ground water. For example, in coastal Alaska where high precipitation is received, it is common to have bogs on hilltops, a position in the landscape that would never support a wetland in Colorado.

Many of our fens are characterized by circumpolar plants that dominate wetlands in arctic and boreal regions as well as in high mountains giving these wetlands the flavor of the far north. This includes the abundant water sedge *(Carex aquatilis)* as well as uncommon and local populations of cottongrass *(Eriophorum* spp.), bog saxifrage *(Hirculus prorepens),* buckbean *(Menyanthes trifoliata)* and many other species.

Many areas with soils saturated for a shorter portion of the growing season than fens support extensive stands of willows (*Salix* spp.). These ecosystems are called willow **carrs**, particularly when they have peat soils and a dense shrub cover. Carrs are abundant in the high mountains and they are usually dominated by *Salix planifolia, S. monticola* and other willows. Bog birch *(Betula glandulosa)* may also be abundant. Beavers many times are important agents of stream damming in the high mountain region, and they surely are responsible for the formation and maintenance of many wetlands. Beavers require willow carr or adjacent upland aspen forest for food and shelter (figure 2).

The **foothills and canyon** region is below the extent of Pleistocene glaciations. Valleys are usually narrow, steep and V-shaped. Stream processes dominate the valleys. Wetlands occur along the streams as narrow bands of shrub and tree dominated vegetation. Narrow-leaf cottonwood *(Populus angustifolia),* alder *(Alnus incana* ssp. *tenuifolia)*, river birch *(Betula fontinalis)* and red-osier dogwood *(Swida sericea)* are most abundant (figure 3). These ecosystems are typically

Figure 2. Aerial view of early summer in a willow carr along the South Fork of Michigan River on the western slope of the Never Summer Range near North Park. Numerous elongate beaver ponds can be seen in the wetland.

Figure 3. Narrow-leaf cottonwood *(Populus angustifolia)* line the banks of the South Platte River near the confluence of the north and south forks in the foothills west of Denver.

referred to as riparian, derived from the Latin word *riparius* meaning of or adjacent to a river. The high energy flows during the melting of the high mountain snowpack periodically erode portions of the floodplain creating gravel bars. This prevents the accumulation of peat and maintains rocky and gravelly soils which are well watered by the stream.

Some wet meadow, spring and pond margin wetlands occur in the foothills region as well but fens are uncommon. Wet meadows are ecosystems that are saturated early in the growing season but dry out enough during the latter portion of most summers to allow aerobic (with oxygen) decomposition of the leaf and root litter to occur. Thus wet meadow soils are not composed of organic matter (peat), but are composed primarily of mineral matter.

An interesting floristic aspect of foothill riparian and wetland zones along the eastern Rocky Mountain front range are

species, such as beaked hazelnut *(Corylus cornuta)* and wood lily *(Lilium philadelphicum)*, which are characteristic of the eastern U.S. woodlands. Most likely during wetter climatic periods in the past, the eastern species were able to expand west along the river systems to cross the area of the Great Plains where they established populations in the Rocky Mountains.

Intermountain parks and basins occur between the mountain ranges and include South, Middle and North Parks, San Luis Valley and Gunnison Basin. All of these areas are in rain shadows of the high ranges and receive scanty precipitation even though they lie between 7,000 and 10,000 feet in elevation. Water running from the high ranges enters the parks and basins as streams, and riparian wetlands occur along many streams. Surface runoff collects in level areas with poor soil drainage forming ponds, and the water leaves these ponds largely by evaporation. Salts accumulate in these sites forming salt marshes. These are common in some areas, particularly in the closed basin San Luis Lakes region of the San Luis Valley. Alkali bulrush *(Bolboschoenus maritimus* ssp. *paludosus)*, three-square *(Schoenoplectus pungens)*, salt-grass *(Distichlis spicata* var. *stricta)*, arrow-grass *(Triglochin maritimum)* and other species are characteristic of these salt marshes. Remarkably these salt marshes have nearly identical species composition to salt marshes found in tidal estuaries along the Pacific Ocean.

Freshwater marshes are dominated by species of rush, particularly *Juncus arcticus,* grasses such as tufted hairgrass *(Deschampsia caespitosa),* manna grasses (*Glyceria* spp.) and a number of sedge *(Carex)* species. Some wetlands in the basins and parks have apparently been created, enlarged or enhanced as ranchers flood irrigating fields to increase forage and hay production. Many of these wetlands now support interesting, rich and complex communities whose existence is precariously supported by human management. Most natural vegetation in the parks and basins has been so modified by human use that it is impossible to determine what types of wetlands occurred naturally.

Spectacular summer floral displays can be seen in many wet meadows in the mountain parks, particularly South Park. The most abundant flowering

Figure 4. Wet meadow in South Park, near Jefferson. The obvious flowering plants are wild onion *(Allium geyeri)* and elephantella *(Pedicularis groenlandica)*.

Figure 5. A very well preserved riparian ecosystem dominated by plains cottonwood *(Populus deltoides* ssp. *sargentii)* along Cherry Creek near Parker on the eastern Plains.

species are bistort *(Bistorta bistortoides)*, purple lousewort *(Pedicularis crenulata)*, elephantella *(P. groenlandica)*, wild onion *(Allium geyeri)*, birds-eye primrose *(Primula incana)* and rocky mountain fringed gentian *(Gentianopsis thermalis)* (figure 4). The most exciting species found in these wetland complexes is the Greenland primrose *(Primula egaliksensis)* which is widespread in the arctic from Alaska to Greenland, but in the continental U.S. is only known from South Park.

Plains wetlands occur east of the Rocky Mountain Front Range in the Great Plains grassland biome. Riparian wetlands occur along all streams that have not been channelized or dewatered. Plains cottonwood *(Populus deltoides)*, peach-leaved willow *(Salix amygdaloides)* and sand-bar willow *(Salix exigua)* are the dominant woody species (figure 5). When John C. Fremont explored the Platte River system in what is now Nebraska and Colorado in 1842, the Platte was 3,000 or more feet wide during the spring runoff and in most places was quite shallow. Trappers leaving the Rocky Mountains with furs bound for eastern markets found that even the main Platte River near Grand Island, Nebraska during the peak of the runoff was too shallow to float a raft. The Platte moved huge sediment loads, continuously reworked its channel and banks, and maintained a very wide actively braiding channel. Woody riparian vegetation occurred only as isolated groves and patches where the river banks were stabilized for several decades; there was not the continuous and densely woody riparian vegetation such as exists today.

Dams and irrigation ditches have totally changed the hydrological and geomorphological processes of our plains rivers. Now rivers have a fairly constant, regulated flow without the sediment erosion and deposition that occurred in the past. Channels are narrow and deep, and channel stability has caused the encroachment of woody vegetation onto the entire old floodplain. The cottonwoods and willows have short-lived seeds whose dispersal is timed to the peak runoff in June. The seeds require bare and moist mineral soil to germinate and establish a root system. Along the upper South Platte River in Colorado where large-scale flooding has largely been controlled, erosive forces necessary to create

bare mineral soils do not occur and little cottonwood reproduction occurs. Most riparian forests in Colorado are dominated by old trees with few younger trees entering the population to replace the dying trees. In addition, intensive cattle grazing and the introduction of Russian-olive *(Eleagnus angustifolia)* and tamarisk (*Tamarix* spp.), which have spread rampantly along our lowland riparian systems, have completely modified these ecosystems. Because the driving ecological forces, erosion and deposition of sediment, have been nearly eliminated in these ecosystems, the original riparian ecosystems may be considered extinct; they have been totally replaced by ecosystems that are not structured by the energy of moving water and sediment.

Wetland Regulation

The Clean Water Act provides that the Corps of Engineers and the Environmental Protection Agency regulate "Waters of the United States," including wetlands. The purpose of the act is to maintain, enhance and restore the biological, chemical and physical characteristics of water in the U.S. Wetlands are regulated under the Clean Water Act largely because they are known to have an important role in maintaining water quality, and also for other wetland functions such as storm water retention and wildlife habitat. Wetlands are also regulated because of their vital tie to interstate commerce associated with the taking of, or recreation to enjoy, migratory waterfowl, fish and other wildlife. It should be made clear that in Colorado wetlands are regulated; they are not protected. Many states on the east and west coasts have developed wetland protection ordinances, but no Rocky Mountain region state has yet done so. However the effort to protect wetlands is beginning in several Colorado cities (Fort Collins, Boulder and Greenwood Village) as local ordinances are now being developed.

Many human activities, for example, housing developments, ski areas and highway construction, can result in the filling of wetlands. Some of these impacts are avoidable by the selection of alternative construction sites; but other activities are water-dependent and impacts are not avoidable. Water-dependent means that the proposed activity must occur in or adjacent to water. Construction of flood protection projects along rivers, and docks and marinas along lakes are considered water-dependent. Few other construction projects are water dependent and alternative sites are usually available that do not require the filling of wetlands and possible deleterious effects on water quality, wildlife habitat and other wetland functions and values.

The Corps of Engineers and EPA usually work within a regulatory framework with parties interested in developing lands that contain wetlands. These agencies occasionally stop projects that threaten wetlands. For example, recently a city north of Denver dug large trenches for draining water from wetlands in South Park to obtain the water for municipal use. EPA consulted with the city and because the material excavated from the ditches was deposited onto a wetland required that this city back-fill the ditches. A general framework used by federal regulatory agencies is that, where wetland impacts are unavoidable, no net loss of wetland acreage and wetland functions occur. Compensatory mitigation is usually required to replace wetlands and wetland functions. Many times this requires enlarging an existing wetland or creating a totally new wetland in a portion of the landscape that has never before been a wetland. One such wetland creation project was performed by the State of Colorado Department of Highways at Chatfield Arboretum, to mitigate the filling of wetlands in Massey Draw during the construction of C-470.

The Chatfield Arboretum Wetland Creation Project

Under a cooperative agreement between

the Army Corps of Engineers who own the Chatfield Arboretum land, the City of Denver Botanical Gardens who manage the land, and the State of Colorado Department of Highways, the Highway Department attempted to create a wetland 18.5 acres in size on the southern side of Deer Creek at Chatfield Arboretum. The construction plan called for the excavation of land down to the ground water table and the spreading of topsoils, which were stripped from the Massey Draw wetlands before they were filled, onto the newly created depressions. The plan was implemented during the fall-winter of 1986. A part of the cooperative agreement also called for a monitoring program to determine whether or not the project was successful.

After the first summer, 1987, three ponds totalling 3.25 acres and three wetland areas surrounding these ponds, totalling nearly 4 acres had been established. The monitoring regime includes 50 permanently marked plots each installed with a ground water well that is measured weekly. The compositon of the vegetation at each well was quantitatively described and compared with the hydrologic regime at that site. The analysis indicates that wetland plant species can become established on sites which have a water table near the ground surface, or are flooded for as little as 10 consecutive days during June and/or July. Once wetland plants are established, they grow best where there is an abundance of water.

Changes were made to the original design to insure a small yet constant flow of water from Deer Creek into the wetlands. In addition, special weirs were built to raise the elevation of the water in each of the three ponds to allow the water to flood and saturate a larger area. During the summer of 1988 plants that were established in 1987 have grown and spread tremendously. A number of waterfowl, including pied-billed grebe, cinammon teal, Canadian goose and others, have successfully nested in the wetlands this year as have red-wing and yellow-headed blackbirds. Frogs and fish have colonized the ponds and wetlands and great blue and black crowned night herons can frequently be seen fishing. Even white-faced ibis have been seen feeding at the Chatfield wetlands.

If a permanent source of surface water from Deer Creek can be guaranteed, then the Chatfield wetlands creation project must be considered a success, even though the wetland acreage actually established is somewhat smaller than the 18.5 acres orginally hoped for. The lessons learned at Chatfield so far are that anyone interested in creating a wetland should very carefully evaluate the water sources that will support the wetland. Ground water cannot be counted on to saturate the ground surface in most locations. They should always save the topsoil from the wetland that will be destroyed and spread it onto the new wetland site. Wetland topsoil contains abundant seeds that germinate rapidly in an appropriately saturated soil and will help establish wetland vegetation. While many of the wetlands that are destroyed are dominated by sedges, rushes, prairie cordgrass *(Spartina petinata)* and other species, most created wetlands are quickly occupied by cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.) and it is not yet known how to control which plants get established and dominate the new wetland.

In dry regions where water is at a premium, wetlands are extremely valuable ecosystems. The diversity of habitat is important to both wildlife and people. In addition, many wetlands provide other important functions including water quality control that is vital to all downstream water users. Wetlands should be preserved and protected wherever possible. Wetlands also invite botanists to put on their rubber boots or old sneakers to explore these fascinating ecosystems, because most of the plants living there occur nowhere else.

FOCUS ON *Carludovica palmata* IN THE BOETTCHER MEMORIAL CONSERVATORY

by Peg Hayward

Carludovica palmata Ruiz & Pav., Panama hat plant is a member of Cyclanthaceae, a small family from tropical America. Some botanists consider this family a link between the palms and the aroids because of the palmlike foliage and flowers like those of the arums. *Carludovica* is a Latinized compound of Carlos and Luisa and commemorates Carlos IV of Spain and his queen, Maria Luisa.

C. palmata is an ornamental, stemless plant 6 to 9 feet tall with dark green fan-shaped leaves. The long leafstalks and flowers shoot directly from the root. Young leaves, folded like a fan, are mounted on solid triangular petioles. As the blades increase in size they split usually into 4 parts, the segments cut again.

The plants are monoecious, male and female flowers alternating spirally on a cylindrical spadix which is enclosed in a 4-leaved spathe. The spadix is remarkable both in form and color. On reaching maturity, it bursts open exposing the scarlet fruit as well as the axis around which it is placed.

C. palmata yields the fiber for Panama hats. Material not good enough for hats is used for thatch, mats, baskets and brooms. Fiber for hats is obtained from young leaves just beginning to fan out. Women cut the leaves off close to the petiole, the base of which forms the center of the crown of the hat. The coarse veins are stripped and discarded. Leaves are then boiled and shredded by hand into strips. The number of shreds into which the leaf is divided determines the fineness of the hat. Six leaves produce enough material for an average hat. After shredding, the fiber is bleached, cleaned and dried in the sun before plaiting begins.

Panama hats are characterized and graded by the fineness of texture, their strength, durability and resistence to water. The hats are actually made in Ecuador, but derive their name from transshipment through Panama to California during the goldrush of 1849. Over 4 million hats are said to be made annually. In addition to local use, they are exported to the United States and Europe.

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Peg Hayward, long associated with the guide training program for Boettcher Memorial Conservatory, Writes "Focus On" as a regular feature of *The Green Thumb*.

Panama hat plant, *Carludovica palmata*

Wetland Plants in the Laura Smith Porter Plains Garden

by Richard Brune

Wetlands — the meeting place of land and water — are among the most productive regions for plant and animal life. From the prairie potholes of North Dakota to the salt marshes of the coast, wetlands are an important part of the world's food chain for wildlife and humans.

The wetland in the Laura Smith Porter Plains Garden at Denver Botanic Gardens is being developed to display some of the wetland plants of Colorado's eastern prairies. These plants grow in a narrow strip along the east side of the Gates Pond where they are kept moist by a drip irrigation system. Additional plants inhabit the edge of the stream which flows from the south end of the Japanese Garden to the Gates Pond.

Although prairie wetlands are not as extensive in Colorado as they are in some other parts of the country, they are a vital part of the prairie ecosystem. Like wetlands everywhere, they have long been regarded as dumping grounds for civilization's wastes; as areas to be drained for agriculture or filled in for development; and as areas to be flooded for reservoirs or used as conduits for irrigation water.

The character of most prairie wetlands is quite altered from that of a hundred years ago. Most formerly perennial streams in eastern Colorado now flow only part of the year because the water is removed for irrigation; also groundwater levels have dropped. Crow Creek and Pawnee Creek on the Pawnee National Grasslands flow for only a short time each year if at all. Falling groundwater levels have eliminated many ponds in the sandhills and elsewhere. Even the character of the remaining perennial streams such as the South Platte River is changed. The tree-lined corridor we view along the Platte is a recent phenomenon. The Platte of a century ago was bare of trees. Shifting channels and scouring of banks and sandbars during spring run-off combined with prairie fires and buffalo to keep the river's banks tree free.

Only recently have wetland values been widely recognized. Wetlands provide food, shelter and breeding habitat for many prairie mammals such as muskrat, mink and beaver; reptiles and amphibians; and ducks, geese and various shorebirds. Plants are the primary producers for all of the animal inhabitants of wetlands.

Other important functions served by wetlands include trapping nutrients and sediments thus improving downstream water quality; removing toxic metals such as lead by trapping them in sediments; and allowing the slow downward percolation of water to recharge groundwater supplies. Wetlands also provide a measure of flood control by slowing the rate of run-off.

Richard Brune, an avid student of the prairie ecosystems, contributed significantly to the re-creation of the prairie plant communities in the Plains Garden at Denver Botanic Gardens.

Wetland plants have various adaptations for living in an environment where the soil is saturated with water at least part of the year. Under the anaerobic conditions occurring in saturated soils, metabolism causes a toxic buildup of ethanol in most plants. Wetland plants are able to halt the metabolic process at non-toxic malic acid. Another adaptation is the presence of air cells (aerenchyma) through which oxygen moves to parts of the plant growing in anaerobic conditions. The spongy tissue in the stems of cattails (*Typha* ssp.) and the swollen petioles of water hyacinths (*Eichornia* ssp.) are examples of aerenchyma. Wetland plants often don't need all of the water their environment provides. They are not large consumers of water. Water serves to keep out the less adaptable upland plants.

Prairie wetlands may be quite ephemeral as is the case in old buffalo wallows where run-off water collects for a few weeks after a rain. They may be intermittent as in a stream flowing for only several months each year. They may also be perennial where water remains year round in potholes or flowing streams.

The ephemeral wetlands formed by old buffalo wallows appear as bowl-shaped depressions on the prairie. They are often an acre or more in extent and about 5 feet deep. Wallows formed where repeated wallowing by buffalo caused large amounts of soil to be carried away in their coats and also blown away when the wallow dried out. When filled by spring rains, these pools become breeding places for toads, salamanders, tadpole shrimp, insects and other prairie animals.

Water clover *(Marsilea vestita)* is a fern that inhabits buffalo wallows and other intermittent prairie wetlands. This small fern, when growing in its emersed form on a muddy bank, at first might be mistaken for a 1- or 2-inch tall four-leaved clover or small oxalis plant. Floating and immersed leaves of similar appearance are also produced when the plant is rooted in shallow water.

Unlike other ferns that produce spores on the undersides of the fronds, the spores of *Marsilea vestita* are in a hard-shelled sporocarp attached to the creeping stolon. This hard sporocarp must be cracked or scarified before water can enter. When water enters, a worm-like organ called a

Water clover, *Marsilea vestita*

sporophyll, emerges. It contains the gametophytes for starting a new plant.

Cracking of the sporocarps was probably done by trampling buffalo initially. Today cattle may serve the same purpose. Ducks and shorebirds feed on the sporocarps and scarification may also occur in their gizzards.

Associated with water clover in dried-up ponds is the spotted evening primrose *(Oenothera canescens)*. This attractive evening primrose has white to pink flowers from late May into July. Those appearing deep pink have a greater abundance of red to pink spots and stripes on the petals.

Fog fruit *(Lippia cuneifolia)* is often found on drying pond margins on the plains and other places with slightly more available water such as the edge of a road. The plant has inch-long cylindrical spikes of white to pink flowers. It can become quite invasive.

Although not a true wetland plant, the adaptable, silky sophora *(Sophora sericea)* often grows in profusion at the high-water line of ephemeral and intermittent wetlands. This pea spreads by rhizomes to form attractive open colonies with white to cream-colored flowers. Look for it, blooming during May and June, growing in the bottom of the arroyo which cuts across the southern part of the Plains Garden.

The earliest blooming of our wetland plants is the butterfly violet *(Viola papilionacea)*. Its violet flowers are produced in early April.

Blooming of the sedges and rushes which dominate the flora of many wetlands follows the butterfly violet. Although the blooms of Nebraska sedge *(Carex nebrascensis)*, spikerush *(Eleocharis)*, and Baltic rush *(Juncus balticus)* are often overlooked because of their small size or lack of bright colors, anyone willing to do a little "belly-botany" with a hand lens will be amply rewarded by the textures and subtle colors of the flowering parts of these plants.

To know if you are "lost in the tules," as the expression goes, you should be able to identify two species of tule or bulrush growing in our wetlands. One of these is the softstem bulrush *(Scirpus validus)* which has round dark-green stems six

Spotted evening primrose, *Oenothera canescens*

Nebraska sedge, *Carex nebrascensis*

feet tall. The other is hardstem bulrush *(Scirpus acutus)* which is similar in appearance but with somewhat triangular stems.

The broad-leaved cattail *(Typha latifolia)* should be recognized by everyone. Growing in moist soil or in water several feet deep, this may be the most utilitarian marsh plant from a human viewpoint.

The pollen of the staminate flowers at the top can be used as flour and the whole flowers are also edible. When green the female catkin below and the male above can be cooked and eaten like corn-on-the-cob.

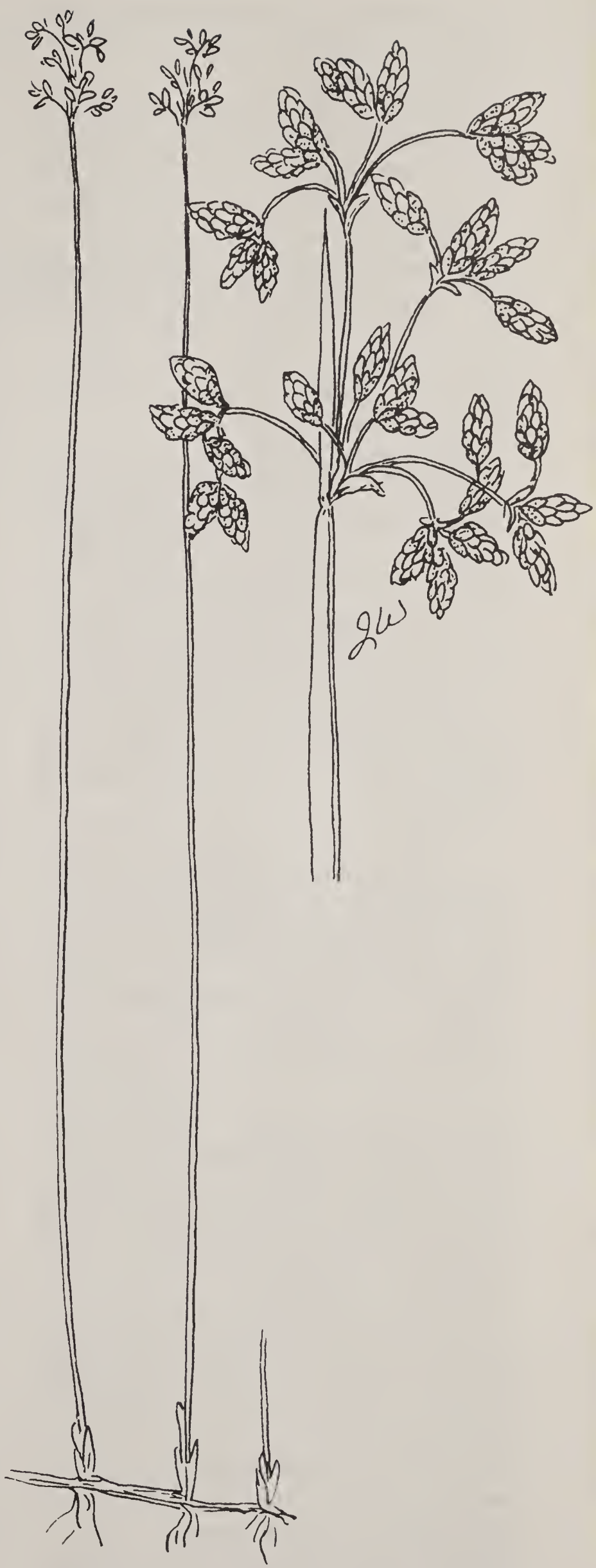
The young shoots can be peeled to reveal the tasty, light yellow inner part which is edible raw, pickled or cooked. This spongy inner tissue is the aerenchyma that transports oxygen to the roots in the anaerobic mud.

Cattail rootstocks can be dug in the fall when they are rich in starch and eaten raw or cooked. Flour can also be extracted from them. Other uses for cattails include caulking, padding, pillows, textiles, and torches. The two bulrushes described are similarly useful.

Two members of the iris family (Iridaceae) bloom in the wetlands in mid-May. Rocky Mountain iris *(Iris missouriensis)* has the familiar blue flowers, but the flowers and foliage are more delicate than those of tall bearded iris of our gardens. Rocky Mountain iris needs plenty of moisture through the bloom period but can be kept quite dry afterward.

Blue-eyed grass *(Sisyrinchium montanum)* at first looks very unlike iris. The half-inch diameter blue-violet flowers present a nearly round symmetrical appearance. They are held 1 or 2 inches above the 4-inch high grasslike foliage.

The foliage of sweetflag *(Acorus calamus)* looks like iris foliage but is actually in the arum family (Araceae). The flowers are tiny and usually overlooked until the flowering spike turns brown in contrast to the green foliage. The foliage



Softstem bulrush, *Scripus validus*

is sweet-smelling when crushed and was used to cover the floor of many a tavern to sweeten up the place.

During July the largest number of wetland species are in bloom. At this time many of the upland prairie plants are becoming dormant due to lack of moisture.

Swamp milkweed *(Asclepias incarnata)* begins blooming on pond margins and in cattail swamps at the beginning of July and peaks 3 weeks later. Lightly fragrant rose-purple flowers are held high for easy sniffing. Slender, erect pods and downy seeds follow.

Slough grass *(Beckmannia syzigachne)*, which bloomed earlier, is easily identified in mid-July. The individual seeds appear in poker-chip-like stacks along the ends of the stems.

Cardinal flower *(Lobelia cardinalis)* displays its aptly named cardinal red flowers on 3 foot stems from mid-July until September. Although it normally grows as an emergent, tip cuttings from cardinal flower can be grown as aquatics in aquaria.

The great lobelia *(Lobelia siphilitica)*, uncommon in Colorado, is named for its supposed medicinal qualities. The bright blue flowers can be found poking out of stands of prairie cordgrass *(Spartina pectinata)* from late July to mid-September.

Agalinis *(Agalinis tenuifolia)* is a rare annual plant about a foot tall. It is easily overlooked until the half-inch rosy-purple flowers appear in mid-July. The flowers may seem disproportionately large compared with the very slender foliage. Agalinis can sometimes be found in the understory of swamp milkweed and prairie cordgrass.

Named for its arrowhead-shaped leaves is the arrowhead or swamp potato *(Sagittaria cuneata)*. Edible tubers on the roots provide the name swamp potato. Arrowhead plants grow three different kinds of leaves depending on growing conditions. Young plants and those in deeper water produce grasslike submerged leaves. As these plants become more robust, elliptical floating leaves form. Later the characteristic aerial arrowhead leaves are produced followed by inch-wide white flowers.

In August prairie cordgrass reaches a height of 6 to 8 feet. This late blooming prairie grass has attractive white to lilac colored stamens. The seed will not ripen until mid-October.

The rough edges of cordgrass leaves give this grass another common name — rip-gut. Close examination reveals multitudes of fine sawteeth along the leaf edges. Cordgrass has been used as thatching and the sawtooth leaves probably helped hold it in place. The strong, thick rhizomes made tallgrass prairie sod containing cordgrass particularly desirable for sod houses.

In early September the latest wildflower to begin blooming in the Plains Garden appears. This is the bottle gentian *(Gentiana andrewsii)*. This gentian brightens the wetlands with its deep blue 1- to 2-inch flowers which are nearly closed at the apex — somewhat resembling a bottle. This is a much more common inhabitant of the tallgrass prairies of the Midwest than of Colorado.

Many wetlands in the Denver Metropolitan area are mapped on the *Wildlife Habitat Map – Denver-Metro Area* recently published by the Denver Audubon Society. This excellent map shows the locations of nearly 200 sites of significant wildlife habitat, public and private, most of which are associated with wetlands. It is available from Denver Audubon, 975 Grant Street, Denver, CO 80203 for $2.00 ($2.75 postpaid).

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The Story of Miss Alice Eastwood

by William G. Gambill

The slim little volume looked very unprepossessing as it lay on my work table. Its title, *A Popular Flora of Denver, Colorado*, had awakened my curiosity several times before when I came across it. Ornamentation of the brown paper cover marked it as belonging probably to the turn of the century, but I found it was published even earlier. "Issued May, 1893" a stamped annotation on the title page within stated. The author, Alice Eastwood, was someone I had heard of occasionally in the past, but I really knew little about her except that she had once lived in Denver and had been a teacher at East Denver High School. Eastwood's *Flora* had been printed by a firm in San Francisco, not in Denver. At the bottom of her preface she gave her address as "Academy of Sciences, San Francisco, Cal."

Who was this Alice Eastwood, really? Where did she come from, how long had she lived in Denver and how had she managed to produce a flora of our area? What had become of her after she left Colorado? Her little book had been published 95 years ago; very few copies seemed to be in existence. Finding the answers to these questions was a fascinating experience, for it led to the discovery of the story of a lady botanist who had achieved international recognition at the height of her remarkable career.

Alice Eastwood's *Flora* was written "with the sole aim of helping students to learn the names of the plants that grow around Denver," the preface stated. She included 487 species, with Latin names and common names, where possible, along with brief descriptions of most except the grasses and sedges. The species were arranged by families in the order followed by Gray's *Manual* (1867). She also used Coulter's *Manual of Rocky Mountain Botany* (1885). Eastwood put together a proper, if modest, scientific flora, based on her own collections. She was a self-taught botanist fired by her intense interest in plants; she never attended college, nor had she ever taken a course in botany.

Searching for information I discovered that a friend of Eastwood had written a fascinating biography, in consultation with her subject (Wilson, 1955). Completed in 1953, the final year of the botanist's life, it was published by the California Academy of Sciences. They also produced another small book as a tribute to Eastwood and her service of 60 years with the Academy (Dakin, 1954). Although out of print, both books are in the Helen Fowler Library at Denver Botanic Gardens. The following account is based almost exclusively on material obtained, sometimes by direct quotation, from these sources.

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Alice Eastwood — 1897

Childhood years

Alice Eastwood was born in 1859 in Toronto, Canada, the first of three children of an Irish mother and an English father. Her father, Colin Skinner Eastwood, was at that time steward of the Toronto Asylum for the Insane; her mother's cousin, Canada's noted neurologist, Dr. Joseph Workman, was director. The family lived in a little cottage on the grounds of the institution. Alice's mother, Eliza Jane Gowdey, who had emigrated to Canada from a hamlet in northern Ireland, was a descendant of fighting Scots who had come to Ireland from Ayreshire centuries before. Alice's relatives were people of great integrity who prized education, though they were not blessed with worldly possessions. She frequently mentioned her awareness of a proud heritage.

When Alice was 6 years old her mother died. Her sister Kate was 4 years old and her brother Sydney only 14 months. Throughout her life Alice remained devoted to her sister and brother, accepting responsibility for them, even with serious interruptions in the unity of the family circle. Her father, being unable to cope with the loss of his wife, gave up his position at the asylum, and parcelled out the children to relatives. For a time Alice lived with an uncle, Dr. Eastwood, who

had a rural medical practice and a home in the country with a large garden. He soon recognized her interest in plants and taught her the names of wild flowers including some of the Latin names. Later she characterized these experiences as the very beginning of her botanical career. Her uncle gave her a small treatise on plants which she prized and remembered as the first book in her botanical library.

Two years later her father gathered his family together again while he was starting a small grocery store and had hired a housekeeper. The housekeeper soon left, and Alice, now 8 years old, had to assume many housekeeping duties. However, her father's store failed and he again had to split the family; the boy was sent to relatives again, while Alice and Kate were placed in a government-supported convent at Oshawa, Ontario, where Alice remained for 6 years.

Although teaching standards at the convent were low, the nuns were kind and devoted. Reading material consisted mostly of lives of the Catholic saints. Alice's favorite Sister discovered her interest and talent for music, including choral singing. An elderly French gardener-priest, Father Pugh, a trained horticulturist who had developed an experimental orchard and garden at the convent, taught Alice to recognize many species of garden plants and how to make tree grafts, as well as to help in the care of the garden. From the nuns Alice learned to sew, knit, crochet, and cook. Food was plain and often scarce, but in the convent environment both Alice and Kate apparently thrived.

A home in Denver

When Alice was 14 she received a letter from her father, whom she had seen only once in 6 years, asking her to join him and her little brother in Denver where he had taken a job. The long train trip was made posssible through the generosity of a family friend in Ontario who was going to Denver and asked Alice to help care for her new baby. The year was 1873. On arrival in Denver Alice found that her hopes of life with her family were not to be realized at once. Her father had arranged for her to live with the family of a prosperous cattleman named Scherrer as a nursemaid for their two small children. Apparently the small hotel where her father and brother lived was unsuitable for a young teen-age girl. In the Scherrer household food was plentiful and Alice, making up for her lean years at the convent, began growing out of her clothes. From their well-stocked library she was permitted to take books to read, and she began to feed her starved mind. For the first time in her life she was able to enjoy the luxury of reading for pleasure and to pursue her growing interest in plants.

When summer came Alice went camping with the Scherrer family in the high mountain meadows and was dazzled with the lush profusion of wildflowers. Never had she experienced such a revelation of natural beauty. Her young mind was stirred to its depths and there was born in it a lifelong craving to know more.

Returning to Denver, Alice found that her father had purchased a lot on Larimer Street in the new business district of the city and was building a store with living quarters at the back. Here she would have a home with her father and brother and would again become the housekeeper. She would be able to resume her schooling which had been so intermittent in the past. She enrolled in the Arapahoe Street School with all grades from primary through high school. Fortunately she was assigned to the classroom of Mrs. Anna Palmer, a remarkable teacher who recognized Alice's unusual capabilities and pushed the young Canadian girl ahead. Mrs. Palmer also taught voice, and Alice again knew the joy of choral singing. At the end of her first year she was ready for high school.

The new high school principal, James H. Baker, later to become president of the University of Colorado, taught his entire student body in one classroom. Again

Alice stood out as a most promising scholar, and as she progressed, he very carefully guided her reading through Dickens, Thackeray and Scott as well as Burroughs and Thoreau, the books coming from the school library.

Colin Eastwood remarried two years after Alice came to Denver. Her stepmother was a well-educated teacher from Massachusetts. A little later Kate came from Ontario and again the family was united. When the new Broadway School was built, Mr. Eastwood became the janitor. The family moved into the basement, and it became the Eastwood sisters' task to clean the schoolrooms every afternoon.

Family finances forced Alice to drop out of school in spring of her junior year to earn money. Although she missed the classroom contact, she was determined not to let her education suffer and continued to study on her own. At the end of the term she was to present herself for public oral examination before she could return to school. In later years Alice recounted that geology was her greatest fear, and the day before the examination she crammed for hours on the subject. The next morning she was questioned in depth on the Carboniferous Period which had enraptured her the day before with its emphasis on the fossilized flora. Her brilliant recitation was flawless.

Alice was a senior in East Denver High School the last year the family lived in the basement of the Broadway School. Her father and brother both carried morning paper routes, so it became her job to make the furnace fires each morning. She got up at 4 a.m. and studied while she tended the furnaces. She worked from 2 to 6 every afternoon and all day Saturday in the dressmaking department at Daniels and Fisher Department Store to earn $12 per month, which paid for her books, clothes, and incidental school expenses. The previous summer she had worked as a cutter's assistant without pay to learn the trade. Twenty girls worked in the sewing rooms, apparently a happy crowd with whom Alice, as the champion buttonhole-maker, was very popular. As graduation time approached, they joined forces to sew Alice's graduation dress — white silk with a flowing train — as a present for her. She was valedictorian of her class in 1879.

Career directions

Before her graduation at age 20, Alice had received an appointment to teach in the Denver schools. Her only experience had been as an occasional relief teacher in the lower grades. A few days after graduation she took a position to teach summer classes in a small country school at Kiowa, 30 miles southeast of Denver. Her former employers, the Scherrers, had helped her get the position, as well as board and room with their relatives. The children in her school were very young — too young for school according to Alice, who decided their parents only wanted to get them out from under foot. She soon turned them into little naturalists who brought their teacher rocks, insects, birds' eggs and wildflowers. By that time Alice had learned something no pedagogue could have taught her — that the children were well-behaved because she had captured their interest in nature. She had no need for using the rod which one parent had sent to her, presuming that she would need it if she were doing her job! Her summer was almost like a vacation, something she had really not known before. In addition, she learned to ride horseback, a skill that would prove extremely valuable in her future career.

Well before this time Alice had realized that botany was her consuming love. A teacher had given her two books, Porter's *Synopsis of the Flora of Colorado* and Gray's *Manual of the Botany of the Northern United States*. Gray's *Manual* was not adapted to the Rocky Mountain region, but she did find a few of the common weeds in it. From it she gained knowledge of plant families and genera, as well as botanical terminology. She had begun her first plant collections and had learned

the names of some of her plants, but she had no one to give her substantial help. She soon progressed further than her teacher, who was friendly but not deeply interested in botany.

The first full year of teaching following graduation was later characterized by Alice as the hardest of her life. Her eighth graders included a preponderance of unruly boys who gave her problems in maintaining discipline, though they couldn't help liking her. She also taught some East High School Latin classes. At year's end she was discouraged, but she must have done better than she thought, for she was given an interim appointment when one of the high school teachers requested a leave of absence. This job required that she fill in for any teacher who left. She soon found herself teaching an astounding array of subjects including drawing, astronomy, natural science, history, composition, American literature and even chemistry, a subject she disliked. She succeeded in all this by doing what good teachers have always done in such circumstances — she studied endlessly, working tirelessly in her spare time, staying ahead of her students, and learning a great deal more than they did.

With a regular teaching position, although it paid only $475 per year, Alice was able to spend summers botanizing in the mountains. She lived frugally making her own clothes; the purchase of books was her only extravagance. As soon as the school term ended she would pack up her oldest clothes, her well-worn shoes and set out for the high country with her books and plant press.

Mountaineer and plant collector

One of her early ambitions was to climb 14,270 foot Grays Peak. On the first attempt she became lost. As daylight began to fade a young miner on horseback stopped to answer her inquiries. She found that she had strayed miles in the wrong direction; thankfully, the young man insisted she ride his horse back to her lodging in Georgetown while he walked along beside carrying her plant press. At the

Chamaechaemactis scaposa (Eastwood) Rydberg. Rare in pinyon-juniper communities in western Colorado

edge of the village he tactfully suggested that they go their separate ways, for he was well known there.

The next day Alice joined others from her rooming house in a horseback ascent of Grays Peak. Someone stole her purse from the saddlebag of her mount, probably one of the horse wranglers. Although she never saw her purse again, her precious plant collections were not molested. In later years when telling the story, she said: "As a matter of fact, I always had more concern for my plants than my money." (Wilson, p. 19)

Her plant collections continued to grow as the summer trips increased in number, and she became well acquainted with the mountains. Her renown as an active botanical collector grew; and she was in demand to guide others who shared her interests.

Recognizing the value of her botanical explorations, David H. Moffat, banker and railroad builder, generously gave her railroad passes to travel and collect in distant parts of the state, at that time criss-crossed by numerous, mostly narrow gauge rail lines. At the end of the line her explorations continued mainly on foot; she was a tireless walker, frequently covering 20 miles or more a day. She visited Steamboat Springs, Gunnison, Durango, Silverton and Ouray. Her plant collections grew summer after summer into a herbarium which she later presented to East Denver High School and which eventually was given to the University of Colorado at Boulder.

Alice Eastwood's desire to travel eastward to visit areas she knew in her childhood and regions of the country new to her inspired her to buy a round trip ticket from Denver to Chicago for $25 during a railway rate war in 1881. Traveling by coach, she saved enough money to continue to Toronto. There she visited her uncle, Dr. Eastwood, riding horseback with him on his rounds to visit his country patients. Her return to the convent at Oshawa was a deep disappointment; everything had changed and she found none of her earlier friends.

She went on to Montreal and Quebec and then to Massachusetts to visit friends of her stepmother who took her to visit Atlantic seaside towns. Thus she found herself one day in Cambridge where she visited the famous Gray Herbarium at Harvard. There she had a rewarding conversation with scholarly Asa Gray, whose books she had been using in distant Colorado. He was then the best known botanist in America and widely respected abroad.

One May morning in 1887 Principal Baker brought to her classroom a distinguished visitor. When her class in Ancient History was finished, Mr. Baker introduced Alfred Russel Wallace, the eminent English naturalist whose explorations in the Malay Archipelago had led him to conclusions nearly identical to those of Charles Darwin on the subject of evolution and the origin of species. Alice had read his famous book *Malay Archipelago*. On his return to Denver from a lecture tour in California, Wallace wanted to climb Grays Peak when alpine

Penstemon utahensis Eastwood. On rocky slopes in Mesa and Montezuma counties

Castilleja scabrida Eastwood. On rimrock ledges in Colorado National Monument

flowers were in bloom. Principal Baker recommended Alice as the most qualified person in Denver to be his guide. Thus began a long friendship between Wallace and Eastwood. The two explored the Grays Peak region for three days of hiking and botanizing amid a spectacular profusion of alpine flowers. Their adventures included staying with the miners at Grizzly Mine, and spending one night in a prospector's cabin at 13,000 feet, reputedly the highest dwelling in the United States. Alice added many specimens to her collection. Years later Alice had the pleasure of visiting the Wallaces at their home in the south of England.

Financial independence

The 1880s were busy years for Alice who spent winters in the classroom and summers outdoors with the mountain flowers. Though she had never asked for a raise, her salary had gradually doubled. She lived very austerely, as she did her entire life, saving some of her salary each month. She added her savings to those of her father and together they bought a corner lot in downtown Denver. At the height of the Denver real estate boom the two Eastwoods sold their property for $20,000, half of which belonged to Alice. She invested half of this in a building her father was constructing with his portion. With the other half, $5,000, she bought two lots and built on each a small brick house in the young mining town of Durango in southwest Colorado. From these dwellings she earned rent which would provide her with a small but steady income for future years. Of that enterprise she declared, "Now I can retire. I can devote all the rest of my life to my beloved botany." (Wilson, p. 27)

For many weeks Alice had been planning a trip to accompany an elderly friend to San Diego, but she was persuaded to stay and help with an unusually large enrollment at East High School for the fall term. The trip was postponed until a replacement teacher for Alice was found. The two friends finally boarded the train for California in December 1890.

New world of plants

Alice entered an exciting new world of plants in the San Diego area. She was challenged by the great wealth of spring flowers she found growing on the mesas and in the arroyos where only the weeds were familiar to her. She worked prodigiously at collecting in the daytime and identifying her specimens at night — doing exactly what she loved to do. Her intense interest in plants brought her into contact with people of like interests in San Diego; one, a well-known horticulturist, Kate Sessions, with whom she enjoyed a lifelong friendship, introduced Alice to California horticulture.

She had read about the botanists of the early exploring parties in California and determined to follow in their footsteps and find the plants they had reported. She started north in May 1891. She was hosted in Pasadena by the noted educator, Mrs. Ezra Carr, in whose garden she first saw a sequoia tree brought from the High Sierras and planted there by the naturalist John Muir. In the same garden grew an English yew, a gift of Sir Joseph Hooker, curator of The Royal Botanic Gardens at Kew. Farther north at Santa Cruz she revelled in the redwoods and the madrones and many other botanical treasures of that region. Then it was on north to sample the flora of Monterey Peninsula. Her real goal was to visit the California Academy of Sciences in San Francisco, the center of research in natural history in California and the West. Here she called on T. S. Brandegee and his wife Katharine, curator of botany at the Academy.

T. S. Brandegee was a civil engineer who served as topographer and botanical collector with the Hayden Survey in 1875. He had made extensive botanical collections in southwest Colorado and adjacent areas, discovering and naming new species. Alice was familiar with his name and botanical activities. At this time he was owner-publisher of a natural history journal, *Zoe,* which was edited by his wife, both a trained medical doctor and botanist. The Brandegees knew about Alice Eastwood's Colorado collections and of her friendship with Alfred Russel Wallace. She was welcomed cordially and they soon became friends. The Brandegees invited her to go with them on their Sunday botanical excursions on Twin Peaks, Mt. Tamalpais, and other localities around San Francisco. Much-impressed with Alice, they urged her to stay in California; but she did not want to miss the spring mountain flowers in Colorado. She returned via Grand Junction, botanized on the Gunnison River, inspected her property in the town of Durango, and then went to visit the Wetherill family at their ranch, The Alamo, near Mancos, Colorado.

Their ranch was attracting considerable attention among archaeologists. Two of the Wetherill brothers, Al and Dick, had been riding the cattle range when they unexpectedly came upon the remarkable ruins known to us today as Mesa Verde. Alice had often shared their

Aquilegia coerulea James fma *daileyae* (Eastwood) Weber. Spurless form of the Colorado columbine

crude camp on the rim of Cliff Canyon, the two brothers digging in the ruins while Alice roamed the mesas collecting plants. This year she had been invited to join them again, giving her a few days for botanizing in the area and cramming her plant presses with specimens.

After she was settled again in Denver Alice undertook writing an article promised to the Brandegees to use in the journal *Zoe*. Her paper she entitled "Common Shrubs of Southwest Colorado." (*Zoe* 2:102-104.) Alice's style was sometimes described as poetic prose and Katharine Brandegee was greatly pleased with her new contributor.

New opportunities

In the summer of 1891 the Brandegees returned from a trip to Connecticut by way of Denver to visit Alice and inspect her plant collections. Upon their return to California, they invited her to San Francisco to help organize the herbarium of the California Academy of Sciences. Her salary would be $50 a month. She saw this as an opportunity to use the excellent library of the Academy — an advantage she did not have in Denver. With her small income from the Durango rentals, she could manage very well, and possibly buy more books for her library.

Alice returned to California as a Coloradan "on temporary leave" in the fall of 1891. In October her essay, "Mariposa Lilies of Colorado," appeared in *Zoe* (2:201-203). Clearly it was the sheer beauty and wonder of the flowers which appealed to her; she described them poetically, yet surprisingly accurately.

In May 1892 Alice left San Francisco, as she had planned the previous year, to join Al Wetherill on a much anticipated exploratory trip in a little known part of the Great American Desert. The Wetherill brothers had accepted her into the camaraderie of the range; her lack of concern for her personal comfort on their horseback trips made her a very acceptable companion. She could handle the hardships of outdoor living as well as could the men. This particular trip was to have more than the usual quota of hardships.

Al was to meet her at Thompson's Springs, Utah, a small station on the Denver and Rio Grande Railroad. He would bring three horses, one for each of them to ride and one for a pack horse. The spring flowers were spectacular, and Alice collected many plants which were new to her, some she was able to name for the first time. Since the country was new to them both, they got lost several times and missed the ranches where they were to stay. Sudden, cold unseasonal rains pelted them until they were soaked, and they had to build fires to dry themselves. Three nights they had to camp out in the open, sleeping on the hard ground with insufficient blankets. On an attempted short cut they became lost again, and Al had to lower Alice and their baggage by rope down into a steep box canyon where she camped alone on a ledge while he tried to find a trail to lead the horses to the ledge before they could go on.

Alice would spread the papers with her plant specimens out to dry in the sun, only to have sudden gusty winds scatter them about. They ran out of food, cooking the last oatmeal in muddy brown river water. Faint with hunger they finally reached an Indian trading post on the San Juan River. But Alice had collected new and rare specimens, and this was enough for her. When telling friends about this trip in later years she would say, "I didn't mind being lost, because I was in new and unexplored country." (Wilson, p. 44)

Between early botanical forays Alice began serious scientific writing with her work on the *Flora of Denver*. She had earlier decided that she wanted to devote her life to botanical writing. However, she could find no one interested in publishing her *Flora*. She scraped together enough money from her own slender resources to underwrite a private edition printed by the Zoe Publishing Company of San Francisco. Since she knew almost nothing about sales promotion, the publica-

tion was a financial loss. Her father, disenchanted with Alice's unbusinesslike methods, finally destroyed all the left-over copies.

In the summer of 1892 Katharine Brandegee offered Alice her own salary — $75 a month — if she would come back to San Francisco as joint curator of botany at the California Academy of Sciences. Mr. Brandegee's financial resources were sufficient for the couple who would then donate their services. Alice was tempted, but she enjoyed living in Denver close to her beloved mountains and close to her family. She could pursue her botanical writing just as well in Denver, she thought. But fate intervened in an unexpected way. The companionship she had been enjoying with a young eastern journalist who had come to Denver for health reasons was ripening into love. She had been hoping that her career might be combined with making a home of her own. However, her young friend had waited too long to come to the healing air of the mountains, and his death suddenly forced Alice to change her course. She decided she should not remain in Denver and grieve, so she wrote to Katharine Brandegee accepting her invitation.

About this time her sister Kate became seriously ill with typhoid fever. Alice stayed in Denver several more months to see her through a long, difficult convalescence.

To California to stay

In December 1892 Alice Eastwood went to San Francisco which would be her home for the remaining 60 years of her life. In that 60 years the remarkable botanical accomplishments of this woman imbued with a profound love of botany would bring her fame and recognition in San Francisco, in California and around the world — fame that she never sought and accepted only with great modesty.

When Alice was in San Francisco earlier, she had been elected a resident member of the California Academy of Sciences. She was also assigned partial responsibility for the California Botanical Club, presiding for the first time on April 26, 1892. Alice became deeply interested in the Botany Club and for 60 years thereafter she directed its activities.

When Mrs. Brandegee retired as curator she arranged for a complimentary passage on the Southern Pacific Railroad to enable Alice to become acquainted with the flora in remote areas of that very large state. All other expenses for her field trips came out of her own salary and small personal income, as she had no Academy expense account in the early years. In those days she lived for one purpose: to botanize in as many parts of the state as she could find it possible to visit. By stage, horseback or on foot she followed the trails that led into the Sierras, the Coast Ranges and the deserts and valleys. On one of her trips in the summer of 1893 she collected specimens of a then unknown shrub in the sunflower family in the dry foothills of the San Joaquin Valley. Later T. S. Brandegee named this plant *Eastwoodia elegans* in honor of Alice.

Before the end of 1893 the Brandegees had left the California Academy of Sciences and taken up residence in San Diego. Their botanical library and private herbarium went with them. At this point the Academy herbarium became the sole responsibility of Alice Eastwood. She set herself the demanding task of caring for the collection and augmenting it.

One of the fascinating aspects of her position was meeting visitors attracted by the renown of the Academy — meeting new plant scientists to whom she now had ready access. One of these was the famous horticulturist, Luther Burbank of Santa Rosa, with whom she collected alpine flowers on the slopes of Mount Shasta. About this time she became acquainted with Dr. Edward Lee Greene, the first professor of botany at the University of California in Berkeley. Although Dr. Greene's views on the naming of plants

a. *Oreocarya humilis* Greene ssp. *nana* (Eastwood) Weber

c. *Aquilegia schockleyi* Eastwood

b. *Phacelia splendens* Eastwood

Alice Eastwood is credited with being the author of 32 separate plants growing within the state of Colorado. Twenty-three of these names are currently in use. For 11 of these, Eastwood's original names are used today. A total of 13 Colorado plants were named in her honor. Five of these names still in use are: *Aletes eastwoodiae* (C. & R.) Weber, *Podistra eastwoodiae* (C. &. R.) Mathias & Constance, *Astragalus eastwoodiae* Jones, *Camissonia eastwoodiae* (Munz) Raven, and *Mimulus eastwoodiae* Rydberg.

This information was extracted by R. L. Shader from *The Flora of Colorado*, a computer generated catalog dated 1988, compiled by R. C. Wittman, W. A. Weber and B. C. Johnston.

Many other western U.S. plants were named by her and also in her honor.

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became highly controversial, Alice was exposed to new ideas from him. Dr. Gustavus Eisen of Sweden, curator of zoology at the Academy in the 1890s, gradually became her firm friend and mentor and his thinking helped shape Academy programs even after he left. He carried on a stimulating correspondence with Alice from various parts of the world where his wide scientific interests took him until his death in 1941.

The longtime friendship with Dr. Eisen brought forth these comments illuminating some of the philosophy that guided Eastwood's life: "Yet in all these years she had never let her relationship go beyond the 'man-to-man' acceptance of a scientific colleague in their curatorial days. That became true with all the men who formed an increasingly wide circle of admirers. As she participated in scientific adventure she gained educational experience beyond what she had missed in her lack of university training. On the intellectual level she was accepted as an equal. Men appreciated her stamina, her cooking — in camp, workroom, or in the home she always maintained. But some way she always raised botany as her shield against romance. 'I never had time for *A* man,' she would explain to her friends, 'but I've always had men friends. I just couldn't let any one of them interfere with my work.'" (Wilson, p. 64)

One of her favorite haunts was Mt. Tamalpais, a majestic mountain across the bay from San Francisco. Here she botanized every Sunday when she was in town. Her attention had been attracted by the manzanitas (genus *Arctostaphylos*) which grew abundantly there. Soon she was certain that she could distinguish five different species. This genus of plants continued to fascinate her for many years and they were the subject of several of her published papers. She and her companions from the bay area with whom she hiked the mountain trails were known as The Hill Tribe. "One of their number, writing a description of their many hikes years later gave a vivid picture of '. . . a famous plant-hunter among them — a hatless, short-skirted, broad-shouldered woman of wonderful strength — who used to trudge easily 20 miles a day with the sun in her serene bronze face and the wind in her flying hair, carrying her heavy plant presses on her back. . . .'" (Wilson, p. 72-73)

Her trips into various parts of California continued, either alone or with interested colleagues, and they brought many new specimens to the Academy herbarium. "From this acknowledged reference center for California flora, she was constantly sending duplicates to Arnold Arboretum, Gray and National Herbariums — unconsciously preparing the way for the time when she would be in the learned circle of those with whom she was now corresponding." (Wilson, p. 84)

Earthquake and fire

Early one April morning in 1906 Alice was awakened by a deafening rumble from the city. The house was shaking most alarmingly. This was the great San Francisco earthquake. In ruins was the fine new building of the California Academy of Sciences. For Alice this meant that the immediate source of her livelihood was gone, not to be replaced for 6 years. She lived in a garret room in an old rambling house on a rocky shelf blasted out of the hillside and was able to retrieve only a few of her personal belongings before it was destroyed by fire.

With the help of friends, Alice dramatically rescued about 1,500 type specimens from the herbarium before the collapse of the Academy building. The herbarium was on the sixth floor and was reached by narrow stairs, now a heap of rubble. She and a friend climbed up via the balustrade that was still intact. With ropes and cord they improvised a lift system with one person at each end, sending down bundles of precious type specimens (those which document the original plant from which the species is named). The bundles were moved several times to keep them from the flames that swept the city. For a

time they were stored at Fort Mason and eventually in the vault of the Crocker Bank until the Academy was in operation again.

Alice was joined by other curators of the Academy in these last minute rescues from their own departments; but gone were specimens and records of 53 years of collecting, some historically valuable and irreplaceable. Eastwood's Colorado and California specimens were destroyed; the loss of the Academy's fine library was a catastrophe. From her desk in the herbarium Alice had snatched up her Zeiss hand lens without which she said she would feel helpless.

From devastation to new vistas

During the next 6 years, difficult financially but rich in many new experiences, Alice had only the small income of $50 a month from her Durango property to insure her independence. She was made to feel at home at the University in Berkeley and invited to share the facilities of the botany department to continue her research. Although she lacked college training, her fertile mind and extensive botanical knowledge as well as her dynamic personality helped her to make new friends and brought new opportunities.

With no ties now holding her in California, Alice decided to go to the Gray Herbarium at Harvard to pursue her studies on plants. A close friend from the Botany Club, which Alice had directed, arranged an invitation for her to stay for a time at "The Manse," the venerable old house in Concord, Massachusetts, which had been the home of Ralph Waldo Emerson, with whose writings she had early become well acquainted. Alice was a popular speaker relating her experiences in the Colorado Rockies and the San Francisco quake to clubs and other gatherings. She visited at the Washington, D.C., home of the C. Hart Merriams whom she had met in California while he was on a visit as Chief of the U.S. Biological Survey. An invitation took her to the home of Alexander Graham Bell. Another time she was a guest with others at the White Hosue where they met with President and Mrs. Theodore Roosevelt. Her old friend, Dr. E. L. Greene, welcomed her to the U.S. National Herbarium where she personally met botanists with whom she had corresponded in her work at the Academy.

In the next 4 years she traveled twice back to California with plant collecting being an important part of her botanical activities. In the winter of 1908-09 she was a paid staff assistant at the Gray Herbarium in Cambridge where her research on the paintbrushes *(Castilleja)* resulted in a scholarly paper, written in Latin, published by the American Academy of Arts and Sciences (Eastwood, 1909). She spent the next winter at the Gray Herbarium again. The following spring Alice's father sent for her to keep house for him while her stepmother visited relatives in Massachusetts. She began to collect plants again in the Denver area to replace those lost in the earthquake. In the winter of 1910-11 she returned to the Gray Herbarium as a volunteer assistant continuing her research and writing, working on the lupines *(Lupinus)*.

She filled out an application for a position at The National Herbarium in Washington which demanded proof of citizenship. She was shocked to learn that she was still a British citizen and could not qualify. She went immediately to Boston to begin the process of becoming an American citizen, a process that was not finalized until 1918.

With her efforts to re-enter professional work in botany stymied, Eastwood decided to visit Europe, using her very carefully husbanded funds. She enjoyed being a tourist in such places in England as Stratford-on-Avon and Warwick Castle. In London she spent weeks at the British Museum studying the California specimens collected by Archibald Menzies, botanist with Vancouver's expedition of 1790-95. One of her interests was

to help clear up misunderstandings in the relationships of the coast redwood and the Sierra "Big Trees" in California. She was welcomed cordially at Kew Gardens; botanists there knew her through her scientific publications. She was invited to many social functions in the homes of Kew staff members. Her greatest honor was an invitation to lunch at the Surrey home of Dr. Joseph Hooker, 94-years-old and long retired as the eminent director of Kew Gardens. He had planted a California chinquapin at the time of his retirement and was anxious to show it to someone from California.

Academy curator again

At Christmas time she took advantage of excursion rates to visit Paris. She researched some botanical problems at the famous *Jardin des Plantes* and at the Louvre Museum, and after an enjoyable visit, returned to the University of Cambridge in England to study lupine specimens from California now in the Lindley Herbarium there. Ten months after she had sailed from Portland, Alice returned to Boston to find a letter in her mail from the California Academy of Sciences inviting her to return to San Francisco to rebuild the herbarium, with a reappointment as curator. Her salary was once more $100 a month, and the Academy trustees had voted her the sum of $200 to begin to equip the herbarium.

Since the Academy no longer had a building of its own, it had rented the first floor of a business building on Sansome Street. Alice rented one floor of an old home on a nearby street where she could both live and work. Here she began sorting the miscellaneous plant collections which had been donated in her absence. Her Botany Club associates aided her search for books for the new library, especially those describing the flora of foreign countries. California had introduced and planted ornamentals from many parts of the world, and they had desperate need of foreign floras. Alice learned, with great relief, of the decision to erect the new building in Golden Gate Park rather than in the Civic Center previously considered. Here rare trees and shrubs from all over the world would be planted.

While she had been away in the East, a group of friends concerned over the future of Mt. Tamalpais had organized to prevent development by eager real estate promoters. They formed the Tamalpais Conservation Club, the TCC. Eastwood had been made a charter member of the club in her absence. The TCC along with other groups succeeded in raising funds to convert the area into a state park. Alice's influence in helping preserve "The Mountain" was so meaningful that years later a hikers' rendevous called Camp Alice Eastwood was dedicated as a surprise on her 90th birthday by members of the TCC.

Hosting the world's botanists

On an autumn day in September 1913, Eastwood was official hostess to a group of distinguished botanists touring the United States as members of the Second Phytogeographic Excursion. These men and women came from Zurich, Geneva, Copenhagen, Amsterdam, Cambridge (England), Berlin, and Sweden as well as from Minnesota, Ohio, Illinois, and other American areas. They were getting acquainted with some of the unique vegetation areas in the New World. Alice and the Botany Club took them on a trip up Mt. Tamalpais. She pointed out many of the native California plants on the mountain to Dr. Adolf Engler, Germany's most eminent botanist and director of the Royal Botanical Gardens in Berlin, and shared with him the dream of creating a great plant demonstration center in Golden Gate Park. Little did she know that day as she met Dr. Carl Skottsberg of the University of Uppsala, Sweden, that in a future year he would guide her as an honored guest on a visit to the home of the great Swedish botanist, Linnaeus.

Early in 1914, Professor Charles Sprague Sargent, director of Arnold Arboretum of Harvard, invited Eastwood to

undertake a trip to Alaska and the Yukon. Her task was to collect willows systematically from the earliest bloom through fruiting and the later appearance of sucker shoots, which are frequently so different from their earlier stems. Sargent sent a check for $700 to cover the expenses of the trip. Academy officials gave their enthusiastic permission asking Alice to collect specimens for them, too. She took the train to Seattle, and then a Canadian vessel on the Inland Passage to Skagway. From there she took the train over White Pass to Whitehorse and continued by stage, a week's journey over the ice, to Dawson. There she rented a miner's cabin heated by a large drum stove in the middle of the living room, but with a foot of ice on the kitchen floor. Her arrival ahead of spring made possible collecting the willows in all their stages around Dawson and some distance north.

By July she had completed her task and was ready to return, sending her collections in burlap bags by express to San Francisco. Her explanation to customs officials that her specimens were not for sale, and that one set was for the Department of Botany of the Canadian Government in Ottawa, enabled her to avoid paying a heavy customs duty on her precious collections.

Upon her arrival in San Francisco in July 1914, Eastwood discovered that the new Museum building for the Academy was being planned with no provision for the botany department. With her usual forthrightness she went directly to the office of the architect and explained the need for space for shelving and especially for herbarium cases — and for a work space and a private office as well. The building, to be called North American Hall, was quite behind schedule, thus giving her a chance to have her say on the area where she would be working for nearly 40 years. At this time her home became a rented cottage high on the northwestern slope of Russian Hill with a magnificent view of the Bay and Golden Gate and the area being prepared for the great Fair due to open in February 1915.

By August 1915 the new quarters were ready for occupancy with the new herbarium cases modeled after the design she saw in the National Herbarium in Washington. Books and specimens were moved from the temporary headquarters to the new building more than 9 years after the destructive earthquake and fire. The botany department library was now growing with a small annual budget of $100 for books. Her Yukon collections and gifts from other sources already demanded the acquisition of more herbarium cases.

During the fall of that year, Alice Eastwood and John McLaren, superintendent of Golden Gate Park, spent valuable hours in a crusade against the threat of destruction of the natural beauty of the Park by a proposed streetcar line to be built across it. She wrote protests, collected signatures on petitions, made speeches to clubs and civic groups; in the end the campaign was successful. The Park's beauty was left intact and North American hall was finally dedicated on September 22, 1916.

Community involvements

Eastwood's "determination to share her knowledge of plant life with all who would learn had inspired her to decorate the entrance lobby of the Hall with an educational flower show. Week after week . . . the graduated shelves she had installed . . . held the longest continuous floral exhibition in the world — the only one of its kind until the Santa Barbara Museum adopted the idea." (Wilson, p.151-2) Here one could find the names and countries of origin of the many exotic varieties of plants growing in Golden Gate Park, as well as native wild flowers.

The California Spring Blossom and Wildflower Association elected Alice "Honorary Life President" and her influence spread through every activity of the organization. When the Spring Blossom Show brought in more than $1,000, Alice suggested they donate some of the money

for a life membership in the Save-the-Redwoods League. In her waning months she knew of plans that the Association would commemorate her 95th birthday by dedicating an Alice Eastwood Redwood Grove. Her sister, Kate Eastwood Phelps, 93-years-old, came from Pullman, Washington, to represent the family at the unveiling of a bronze plaque designating 20 acres of virgin redwood timber in the Prairie Creek Wilderness area 50 miles north of Eureka, California, as a memorial to Alice.

In the spring of 1929 Eastwood founded the American Fuchsia Society which thrived on her enthusiasm. That same spring she began plans for a European trip to combine attendance at the meeting of the British Horticultural Society in London and responsibility as official delegate of the Academy to the Fifth International Botanical Congress in Cambridge, England in August 1930.

She visited gardens and nurseries in England, Edinburgh and Dublin. While in Ireland she sought information about her mother's family and enjoyed visiting the village where her ancestors had lived. Again she worked in the herbarium of the British Museum and squeezed in a side trip to Paris to do some work at the Natural History Museum there. She and her traveling companion who was a Botany Club friend and an authority on roses, were gone from July to November on a trip that brought rich rewards to the Academy and to her California projects. She brought home cuttings from many varieties of fuchsias cultivated in western Europe, gifts of nurserymen and curators of gardens.

When Alice was back at her desk at the Academy after a protracted bout with pneumonia, she began work on an article on species of fuchsia cultivated in early California. A friend had given her a valuable 1858-59 manuscript recording the plants growing in San Francisco Bay area gardens in the earliest pioneer days. The article appeared in *National Horticultural Magazine*. (Eastwood, 1931)

One early April morning Alice was greeted by Botany Club friends bringing armloads of wildflowers — 89 varieties of them — for the Academy exhibit. The flowers seemed to renew her energy. Later, a week spent in the desert heat of Arizona afforded her needed rest as well as new opportunities for plant collecting. Her days and weeks were full as she fulfilled requests from garden clubs and other groups to share her knowledge and advice. She identified grasses for allergists and mushroom specimens for the coroner's office in suspected poisoning cases. Amateur collectors came to her office seeking help in naming their plants. Answering letters requesting plant information of all sorts took time.

On her way to the office one July morning in 1931, Eastwood was struck by a car at the entrance to Golden Gate Park. She suffered a badly crushed left knee and after surgery at Stanford Hospital, spent many weeks with her leg in a cast. By the time she was released at the end of October, she had graduated from crutches to a half-cane. After her recovery Alice maintained most of her activities except vigorous walking and climbing. The unexpected acquisition of a car enabled her, with assistant curator Tom Howell, to resume extensive collecting trips.

Near the end of the year Eastwood and Howell invested their own money in a new quarterly publication, *Leaflets of Western Botany*. This became a significant professional outlet for their writings as well as for other botanists' works.

In January 1933 she was asked to help advise puzzled horticulturists who met to explore ways of avoiding future plant damage from "black frost" which had caused tragic losses the previous month. An outgrowth of that meeting was the formation of a new organization, the California Horticultural Society.

In June 1933, Howell, Eastwood — now 74, and an old friend drove the Academy Ford to Salt Lake City, host to the meetings of the Pacific Division of the American Association for the Advancement of

Miss Alice Eastwood (1859-1953) on her 80th birthday, January 19, 1939.

Science where Alice gave a lecture on the genus *Castilleja*, the paintbrushes. They collected specimens along the way, taking five days for the journey. At the close of the meetings, the three continued on to Bryce Canyon, Zion, and Grand Canyon National Parks, returning home by Hoover Dam. Alice was unable to collect; her job was to put the plants in the press and keep the records, but she enjoyed it all greatly.

Eastwood's plans to attend the Sixth International Congress in Amsterdam in 1935 included her assistant curator, Tom Howell. She needed a strong arm to lean on; and she wanted Howell, as her intended successor, to meet the botanists from other countries whom she had met earlier. The trip was to take 6 months; as a compliment to Howell, she personally assumed the expense of his round trip fare. Their visit began with attendance at the 300th anniversary of *Le Jardin des Plantes,* the renowned botanical garden in Paris. In the two months which were to elapse before the meetings in Amsterdam, Eastwood and Howell went to London to work in the herbaria of the British Museum and the Royal Gardens at Kew. At the meetings in Amsterdam, Alice met old friends and Howell made new acquaintances.

Back home in San Francisco, trips in the Academy automobile were soon resumed. One of the most interesting and heartwarming for Alice was a return visit to the Wetherills — now in Arizona, and to Mesa Verde in Colorado, after an interval of 48 years.

Recognitions and celebrations

The 80th birthday of Alice Eastwood was the occasion of a vast outpouring of recognition, friendship and love by her friends and associates in California and around the world. More than 450 guests sat at tables in the Fairmont Hotel which was decorated by branches of flowering trees and shrubs and other floral tributes. Letters and telegrams of congratulations filled a basket on the table in front of Eastwood. Among the guests were three from her days in Denver — a classmate from East Denver High School, one of her fellow teachers, and one of her former pupils who had retired to devote her own life to botany.

In the last weeks of 1941 the threat of possible air raids and submarine attacks on San Francisco by the Japanese caused great concern for Eastwood. Remembering the disaster suffered by the Academy in 1906, she began to store valuable type specimens in the Academy vaults.

In December 1942, the Academy celebrated the Alice Eastwood Semi-Centennial. Eminent scientists from all over the West congregated for the day when the Academy would present its highest honors to Eastwood. A new series of publications called *Alice Eastwood Semi-Centennial Publications* was announced. It was there that the new president of the Academy, M. E. Lombardi proclaimed: "On her 90th birthday, Miss Eastwood will, at her request, retire from her post as Curator of Botany. The Academy's Council is proud to grant her the title of Curator-Emeritus — a title which, however, seems singularly inappropriate to a gallant lady who will be forever young." (Wilson, p. 208)

At the Academy, President Lombardi presented her with a gold medal, saying "The Academy honors itself in honoring her." (Wilson, p. 209) Bronze medals were awarded her by the San Francisco Garden Club and the American Fuchsia Society. At its birthday dinner for Alice, the San Francisco Garden Club announced that it had established a Scholarship in Horticulture at San Francisco City College, the qualified recipients to be known as Alice Eastwood scholars. Also at this dinner, Dr. Miller, director of the Academy, "called attention to the fact that in addition to these personal services [to botany and horticulture] Alice Eastwood had published over 300 items on botany — 200 of which were written after her 50th birthday. 'Thanks to her,' he concluded, 'the collection of botanical

specimens in our herbarium in Golden Gate Park now exceeds 300,000.'" (Wilson, p. 211)

The ultimate recognition of Eastwood's accomplishments was yet to come. She received an invitation from her old friend, Dr. Carl Skottsberg of the University of Uppsala, to come to Sweden as an honorary president of the Seventh International Botanical Congress in Stockholm in 1950. This was recognition beyond any she had ever dreamed.

One of the more touching stories of Eastwood's newest adventure concerned the purchase of a new dress for the occasion. A friend had sent her $100 to buy a new gown for the Congress "dress-up" affairs. Eastwood was notorious for not spending money on clothes. She made her own, and always looked nice, but she thought nearly everything was more important than clothes. She greatly admired a dress worn by another guest at a luncheon. "Learning that Mme. Clara, a White Russian couteriere had made it, she called a cab and went immediately to the establishment . . . 'I was about to retire from business,' the designer recalled, 'too weary to carry out plans my husband and I had made for a trip around the world; but when that little old lady came in full of enthusiasm to order a dress to use a year hence on a flight across the world, my faith was reestablished.'" (Wilson, p. 218)

Eastwood kept very busy in the months before her departure for Sweden, working from time to time at her desk at the Academy and attending the weekly meetings of the Botany Club. Her friends gave her a farewell luncheon; and then, at age 90, she embarked alone on the most memorable trip of her life. As her plane circled the airport at Stockholm, she must have glowed with the realization that she was, at last, coming into the country where the great scientist Carolus Linnaeus had lived and worked. As Honorary President of the International Botanical Congress she would be received by the King of Sweden.

Dr. Skottsberg met her at the ramp and steered her through a crowd of Swedish journalists who were eager to hear her story, which was spread over the Stockholm newspapers the next day. To Alice Eastwood the supreme reward for the long journey came when she was invited to sit in the chair of the great Linnaeus. Her early days were comparable in many ways to those of the young man whose chair she momentarily occupied. "Her own parents like those of young Carl Linne . . . had been poor in worldly goods, but rich in the heritage of mental and moral capacity which they had bequeathed." (Wilson, p. 3)

In mid-October of 1953, when she lay critically ill in Stanford University Hospital, news was given her by Mrs. Wilson that she had been selected to receive a Citation of Merit from the American Horticultural Council. Her request that her friend deliver to them her deep thanks was one of the last spoken responses she ever made. She died in late October, leaving behind countless friends, associates and other admirers marveling at the richness of her life and the gifts she had so generously shared with her fellow human beings.

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